SCHOOL SCIENCE AND MATHEMATICS

VOL. XXXVIII JANUARY, 1938 WHOLE NO. 327

CHARLES MARK TURTON
1861–1937

CHARLES MARK TURTON

In the death of Charles M. Turton on November 24, the Central Association of Science and Mathematics Teachers lost its most faithful member and SCHOOL SCIENCE AND MATHEMATICS lost its most consistent and critical reader. Mr. Turton's contributions to these enterprises were most noteworthy and even after his retirement from teaching he maintained an active interest in their welfare. He never missed a meeting of the Association until illness prevented him from going to St. Louis in 1936. He gave unstintingly of his time and energy whenever he was called upon to serve upon the Executive Board or some important committee.

Mr. Turton was born June 3, 1861 at Konona, New York. After completing his preparatory education at the Academy at Onondaga, New York, he entered Syracuse University in 1883. He was graduated from this institution at the age of 22, the youngest member of his class. Three years later he received the degree of Master of Arts. During the ten years that he taught in New York and three adjoining states he served in nine public and private schools.

Mr. Turton came to Chicago in the summer of the Columbian Exposition in 1893. He taught one year in Lakeview High School and thereafter in Bowen High School. At first he taught both Physics and Chemistry, later he devoted all of his time to Physics up to his retirement in 1931. At the time of his retirement he lacked only two years of having taught for a period of one half century.

His interests extended beyond the classroom. When the teachers of science and mathematics began to organize for the welfare of their profession he was found in the front ranks of the promoters of this worthy undertaking. He was a charter member of the Central Association of Science and Mathematics Teachers and was its only member who attended every meeting for thirty-five years.

He aided also in establishing SCHOOL SCIENCE AND MATHEMATICS and was its very able and efficient business manager for twenty-four years. During these years the JOURNAL became internationally known as the outstanding publication for teachers of science and mathematics.

The strenuous and selfsacrificing efforts that were required to promote the new venture when the JOURNAL made its first

appearance are vividly portrayed in "Reminiscences of Charles Mark Turton" which he wrote after his retirement from teaching. The following is a short passage taken from these "Reminiscences."

"In the spring of 1901 C. H. Smith and I frequently talked about starting a magazine for science teachers, especially physics, as there was none published in the English language. Also we discussed the plan of organizing an association of physics teachers.

"A meeting of physics teachers was called in May 1901. About a half dozen were present, among them one from Iowa who was at that time visiting the University of Chicago. Another meeting was called a month later which resulted in the formation of the Central Association of Physics Teachers with Mr. Smith as president. In 1902 it became the Central Association of Science and Mathematics Teachers. In the meantime C. E. Linebarger, physics teacher in the Lakeview High School, had begun publishing *School Science*. This was made the official organ. In 1904, while I was Secretary of the Central Association of Science and Mathematics Teachers, Mr. Linebarger discontinued the publication of both *School Science* and *School Mathematics* after having issued only three numbers of the latter. As Secretary during the fall I began receiving letters of inquiry from our members about the non-receipt of the magazines.

"At the regular meeting of the Association held during the Thanksgiving recess of 1904 the uppermost topic for discussion was the continuance of the magazines. The final outcome was that C. H. Smith and I were persuaded to take over the two magazines. We told the Association that we did not have any money to lose on the venture but would undertake it on the condition that twenty members would sign a guarantee of fifty dollars each to reimburse us against any loss for the first year.

"Mr. Smith took the editorial part while I became business manager. We struggled along the fist year from hand to mouth paying each month's bills after the subsequent issue was published. We ended the year with all bills paid. This relieved the guarantors from any financial obligations.

"In order to get second class rating we extended old subscriptions three months, using every possible excuse for doing this. By doing this a mailing list of about 1200 was finally ac-

cepted by the postal authorities. We consolidated both magazines mentioned above into one called SCHOOL SCIENCE AND MATHEMATICS.

"I never worked so hard in my life as during the next few years. I visited science and mathematics teachers' associations in Missouri, Chio, Indiana, Michigan, Illinois, Wisconsin, and New York in the interests of the new journal. Smith and I attended the National Education Association meeting at Asbury Park, New Jersey, in July 1905. We distributed 100 copies of our journal to attending teachers. Our expenses on this trip were paid from journal funds. We closed the school year with all bills and all expenses paid."

In addition to his regular work in the classroom and his efforts in behalf of the teachers of science and mathematics, Mr. Turton was also joint author of a chemistry manual, two physics manuals, and a textbook of physics. He was a member of the honorary fraternity, Phi Kappa Phi, of the Illinois Academy of Science, of the American Association for the Advancement of Science, and a member of several other scientific and educational organizations.

Throughout his life he was an ardent churchman. In 1915 he was one of a small group who organized the Bryn Mawr Community Church, which he served in an official capacity until his death. His pastor said of him: "For twenty-two years he set this congregation an example in devotion, in regular attendance, in generous service, in strong and enlightened faith, in cheerfulness, in leadership, in loyalty, and in admirable Christian manhood."

J. M. KINNEY
J. M. KURTZ
G. W. WARNER

A TRAVELING CLINIC

An operating room on wheels has been put on the road in Germany. It was designed by a woman physician, Dr. Elisabeth Schenck of Bonn. Its primary purpose is to serve schools as a traveling dental clinic, but it can also be transformed into a surgical operating room and used in case of wrecks, mine disasters, and other emergencies.

The body is insulated against both heat and cold, is well ventilated, and provides both shadowless daylight and strong electric light for the operations. Hot and cold water are provided, as well as heat for sterilization. Instruments are protected in drawers. The dental chair can be converted into an operating table by the addition of a specially formed metal plate.

A CHALLENGE TO CHICAGO

The Central Association of Science and Mathematics Teachers has held the last two conventions in St. Louis and Cincinnati and has thus broken with the tradition of meeting every other year in Chicago. The interest shown and the support given by the teachers of science and mathematics in the middle west to these last two meetings has kept the Association in its position of leadership in the teaching field.

President Teeters, the Cincinnati teachers who planned many of the details, and those who took part in the program are to be congratulated. The general and sectional meetings sent the members back to their respective schools to more intelligently solve the problems of effectively reaching the individual boy and girl. Old friendships were renewed and new acquaintances were made. Those who did not attend, will have opportunity to read a more detailed account of the general and sectional meetings in this number of the Journal. The papers which were given will appear in this and in later issues.

Chicago, because of its central location, is an ideal center in which to hold the 1938 convention. The committee, in selecting Chicago, was assured that the administrators and the teachers of mathematics and science in the Chicago Public Schools would assist in every way possible to make it a success. The many educational institutions of higher learning in and around Chicago should furnish a wealth of talent for the meetings. The museums, conservatories, aquarium, planetarium, and industrial research laboratories should all be reasons for a large attendance from other cities. Vice President J. M. Kinney is a member of the faculty of the Wilson Junior College of Chicago. He has been active in the Association for many years. President Ira Davis of the University of Wisconsin High School has had much experience in planning programs for similar meetings. Let's all plan to help in every way that we can to make the 1938 convention the best we have ever had. LET'S GO CHICAGO. LET'S GO ASSOCIATION.

HAROLD H. METCALF

THE ARTICLES IN THIS ISSUE

All of the major articles in this issue are papers delivered at the Thirty-Seventh Annual Convention of the Central Association of Science and Mathematics Teachers held at Cincinnati, Ohio, November 26 and 27, 1937.

INTRODUCING MATHEMATICAL CONCEPTS IN THE JUNIOR HIGH SCHOOL

By David W. Russell

National College of Education, Evanston, Illinois

In recent years we have frequently listened to pleas for the integration of mathematics and heard emphases on its importance as a foundation for the understanding of the social and physical sciences. Strongly hinted from time to time were implications that too much pedagogy has been mixed with the teaching of mathematics and that poorly trained teachers were running the subject to rack and ruin. For a while it seemed that educators with their philosophies and methods were being challenged but as time went on it was recognized that there is a need for strong cooperation between the subject matter specialists and those primarily concerned with education as a whole and the persons on both sides must share the contributions and complaints of the others. This afternoon we are not primarily concerned with controversies of this sort but we are more interested in the means and the effective ways for giving the important mathematical concepts and useful abstractions to young people in the junior high school so they will recognize, think, and use mathematics in its relation to their everyday experiences. This method may sometimes be called functional arithmetic but it is a poor name because functional arithmetic implies only that which is practical and useful and we are also concerned with mathematical relationships though they may not possess a practical aspect. This combination is a high grade of mathematics and borders on the suggestions for integration. It can be worked into a firm foundation at the junior high school level for the more advanced calculations and concepts that are on the road ahead. There are many approaches to capitalizing on the values of arithmetical concepts even in the early junior high grades. During the last year we have experimented with a plan that has been reasonably successful. It may not be as workable in all of your schools as it was in ours but we hope it will suggest some idea that can undergo further improvement.

How the Experiment Started

A year ago a group of our junior high school youngsters were collecting specimens on a science trip in the immediate neigh-

borhood. In the course of the conversation the children were asked to estimate the altitude of different objects such as houses, apartment buildings, church towers, trees, and telegraph poles. In comparing their estimates it was astonishing to find that their judgments of altitudes, distances, and other mathematical applications were for the most part unreasonable and considerably out of proportion. The children were quick to excuse themselves on the grounds that arithmetic had little to do with their science excursion but they did recognize that mathematics can live outdoors as much, or even more, than it

FIG. 1. A study in perspective.

does in the classroom. So we decided to do something about it by making transits in the shop and go exploring for mathematics in the neighborhood. Exploring was fun and the calculations became meaningful and interesting. If you will try it yourself sometime you may find that your results will be similar to ours or probably better.

Several months later the same group was taken for another hike. It was extremely interesting to hear the spontaneous conversation drift to some of the mathematical concepts in the neighborhood. The experiment which has only been briefly told was very interesting. The calculations, proficiency in numbers and problems and accuracy were certainly included but the neighborhood experiences helped tremendously to add life and

interest to the mathematics classes. This phase of arithmetic is often lacking in the early junior high school grades. The reason is not that the general idea is new but rather that the preparation, equipment, and classroom freedom of the teacher are often limited. The foregoing experiment was developed during the period of the school year with every opportunity utilized to bring to the pupils' minds the everyday application and consumption of arithmetic. Scrapbooks were made including newspaper accounts of activities relating to mathematics. Pictures, labels, and any other item that illustrated the impor-

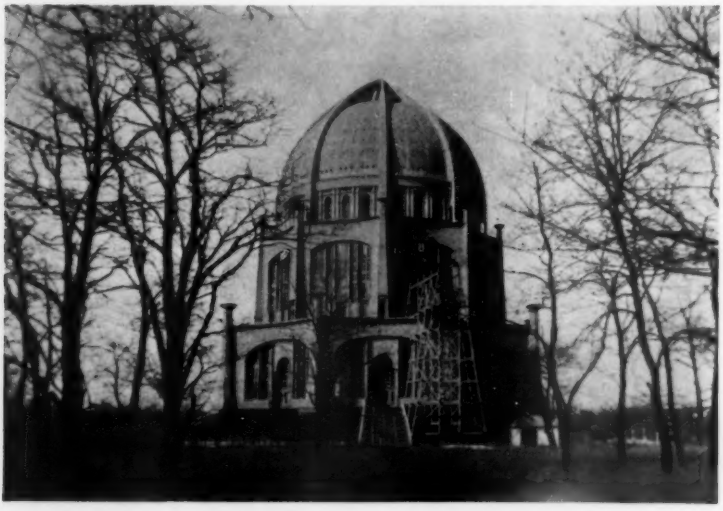

FIG. 2. The curves and angles of Bahai Temple.

tance of arithmetic were collected. These ideas and activities suggested even more ideas and activities. Why shouldn't we relate mathematics to social and community activities as a means to prepare children for a better understanding of the social and physical sciences? If we want to try this, good pictures we could take ourselves would certainly be helpful.

HOW PICTURES WERE USED TO INTRODUCE MATHEMATICAL CONCEPTS

During a vacation trip from Evanston through the southwest to Mexico snapshots were taken that could be made applicable to mathematics. These we call mathematical pictures. You are going to see thirty-five of them on the screen and as you look at them try to associate mathematical concepts with

the pictures just as the junior high school people did. In figure 1 we have an unusual view of perspective which is one of the easiest of the many mathematical concepts to photograph and to recognize. This picture was taken on the highway between Houston and Corpus Christi and is really unusual in its implications. In figure 2 is the Bahai Temple, a structure of unusual architecture employing curves, angles, configurations of design and symmetry. This can be looked at as a "living" example of some of the mathematical concepts included in junior high school curricula. We are fortunate that this Temple is almost

FIG. 3. Mathematics in the oil industry.

next door to our college which makes it convenient for our classes. As one child remarked, "It's full of mathematics and religion" which is a rather good statement. In figures 3, 4 and 5 we have illustrations of a few life situations in industry and power. The mathematics of shooting an oil well can involve some well rounded problems as well as the science and interest that is evident. The very circular nature of the great Bingham Canyon Copper Mine near Salt Lake City and its relationship to the production, smelting, and transportation of copper is full of mathematical concepts, hundreds of them. The Boulder Dam, its construction, its power, and its importance as a common topic for discussion and visitation suggests problems and topics of every sort. Excellent material relating to the

mathematics of the Boulder Dam can be secured free from the United States Government or the western railroads. In figure 6 we have a view of a Chicago "L" station in the heart of the

FIG. 4. Bingham Canyon copper mine.

FIG. 5. Parabolas at Boulder Dam.

country's second largest city. This very statement involves possibilities for computations and investigation into the arithmetic of elevated lines. Now in figure 7 we have a different sit-

uation. Here we have the remains of a huge barn that was full of hay, machinery, and cattle just twelve hours before this

FIG. 6. Mathematics on the "L" platform.

FIG. 7. A study of insurance on the farm.

picture was taken. The barn burned to the ground. They called it spontaneous combustion. Cattle were burned, machinery destroyed, tons of hay went up in smoke and flame and of

course the structure itself was a total loss. This all happened at Lander, Pennsylvania, one evening last summer and in this situation as well as the others, mathematics of a unique and interesting nature can be prescribed. In figure 8 we have a more common occurrence. In this picture are the remains of three trucks which collided and were ruined by fire near Kendallville, Indiana. Two men were burned to death and the third one was fighting for his life in a nearby hospital. Pictures like these can open eyes, they can open eyes to mathematics as it is applied to human activities that are sometimes close to home.

FIG. 8. Destruction of life and property on the highway.

It is not necessary to travel five or six thousand miles to take pictures which represent all phases of the mathematics of human activities. Mathematical pictures may be found in any environment if we will just look for them.

ONE OUTCOME FROM THE USE OF MATHEMATICAL PICTURES

We must remember, of course, that it is the use of materials that makes the materials important. Anyone will look at pictures with keen interest, especially pictures of an unusual nature. This trait has been illustrated by the success of several of the new picture magazines that have swept the country

with their popularity and brought to the eyes of thousands upon thousands of persons panoramas of the activities of man throughout the world. Why not use this principle in introducing concepts of mathematics to junior high school people? Doesn't it seem worth trying?

When the junior high school classes assembled in the fall the children were looking for something new for whether it is fortunate or unfortunate, most children look at promotion to junior high school as a great jump into maturity and independence. They have had calculation for calculation's sake, they have worked with percentage, interest, fractions, and the other common kinds of arithmetic. The junior high school should bring something different. This is exactly what happened, for during the first few classes enlargements of these pictures were presented for discussion. These pictures were real scenes and some of them were similar to experiences the children had during the summer. You must believe me that discussion was spontaneous and enthusiasm spread over the class. Enthusiasm for what? It was going to be some enthusiasm for mathematics if the well laid plans materialized.

Through discussion, problems in mathematics naturally developed, relating to such topics as insurance, design, power, construction, transportation, safe driving and other subjects. They are modern topics involving arithmetic so these young people wrote essays on the pictures, driving ahead with their ingenuity and analysis to discover as many relationships as possible implied by the pictures. Mathematics was becoming real, it was living, living in these very pictures that their teacher had taken.

After the essays were complete and we really had absorbed some mathematical concepts we began to develop our mathematics laboratory which, like the science laboratory, was to be a place for experimentation with numbers and calculations of interest. In the laboratory, which is not yet completed, is an adding machine, a demonstration slide rule, triangles, drawing boards, home made "T" squares and other incidental equipment and machinery. In figure 9 are some of the children experimenting and handling numbers and calculations in an interesting way. By means of such activities mathematics becomes a pleasant recreation. You must not suppose for one minute that skills are being neglected or problems shelved in favor of a sugar coated procedure. Rather we have hoped to

make the actual number work more complicated by using problems more meaningful than the ready-made stock material. Some of our friends are worried because educators seem to be squeezing mathematics from the curriculum. This is not true for rather than force arithmetic from the curriculum we are trying to make it livable in the lives and thinking of young people and to rearrange the subject matter to the places where it best fits. Many of us believe that one of the best ways to bury mathematics is to drive and force meaningless calculations into the minds of the children without reasonable regard for applications and relationships.

FIG. 9. The mathematics laboratory.

ONE OUTCOME—DEVELOPING AN INTEREST IN INSURANCE

The children's favorite pictures were the ones relating to accidents and destruction which may not surprise you but still may be a matter of considerable concern. This seems to be common among adolescents and probably just as common among adults and even school teachers. The favorite pictures gave us a cue; so our arithmetic class embarked on the study of insurance and found considerable help in their textbooks and reference material. Children like organization, so do adults. We have learned this during the last few years. So we organized an insurance company with stock, policies, directors,

salesmen, adjusters, and all the trimmings to make the company a functional mathematical and social activity. Lantern slides were made by the children to fully illustrate some of their correct and incorrect interpretations of the meaning of insurance. These show the emphasis on damage and loss with insufficient recognition of prevention. These are some of the concepts we had to iron out. The children's company offered protection against loss of pencils, books, and other small items with activities on the part of the company to take measures against unnecessary loss. There is not space to describe all the details of the plan but the stock certificates illustrate a few of the mathematical relationships. Is this kind of an activity worth the time? We think it is. Does it replace calculations and problems in the classroom? Does it replace mathematics? No, it intends to supplement mathematics and create a greater respect for a system that has taken hundreds of years to develop.

In the course of the development of our company investigations of real insurance companies were underway. Sample policies—fifty-five of them—were collected by writing letters and soliciting the cooperation of friends in the insurance business. Mortality tables were fascinating, premiums and dividends were interesting, and percentage and decimals were not just "problems on page fifty."

You can well imagine that vocabulary and spelling became a problem in the "insurance business." The children surveyed the real policies they had collected and the most popular were the "kidnapping" and "burglary" contracts. It is not difficult to understand the reason for this. The next most popular were the policies relating to automobile insurance. From a survey of all these policies the class made a list of the insurance words which follow. Look over these two hundred and seventy-seven words and see how many of them have meaning to you. Are they just words or do they bring an association of mathematics and its importance in one of the nation's largest businesses? Many of these we used in composition work as well as in incidental discussion of our insurance business.

Developing Some Mathematical Concepts of Safe Driving

The study of insurance is not the only outcome in developing mathematical concepts along the lines of human activities.

Word List Made by the Eighth Grade from a Study of Insurance Policies Collected by Mail or Donated by Teachers and Parents

abandonment
abet
abstract
abstraction
abstracted
accident
accordance
account
accrued
accruing
acknowledge
adjuration
aeronautics
affirmative
aforesaid
alcohol
alleging
alteration
altered
amended
annual
annuity
annum
applicable
appended
application
appraisal
appraisor
appurtenances
arbitrator
ascertain
ascertained
ascertainment
asset
assignments
assignee
assurance
authorities
authority
authorized
automatically
avoid

bailee
bankruptcy
beneficiary
bills
bonds
bullion
burglar proof
burglary

centum
cancellation
claimant
chattel mortgage
codefendant
clause
cognizant
collateral
collectible
commission
commotion
commutation
compartment
compensation
competent
competitive
complied
computation
conditional
condition
confiscation
conform
consecutive
consecutively
consequent
consideration
contingency
constitutes
contract
contrary
cooperate
cooperation
conversion
converted
conveyance
countersigned
custodian

damage
declaration
deduction
deductible
deemed
defining
defense
deferred
demolition
depreciation
derailment
designated
destruction
deterioration
discharge
domicile

electrical
embezzlement
embodies
enacted
enactment
encumbrance
endorsement
enumerated
equivalent
estimate
estop
evidence
executed
excess
excess of maturity
excess premium
excerpts
expedient
expense
expired
expiration
extended

facevalue
facilities
felonious
feloniously
fireproof
forcible
fraud
fraudulent
fraudulent scheme

government
governmental
gradual
granted

hazard
hostilities

illicit
imburse
immediately
imperative
inaccessible
incontestible
inclusive

inclusion
incurred
incumbered
indebtedness
indemnified
indemnity
inherent
internal
interrogate
interrogative
insolvency
insolvent
instalment
insure
insurrection
invalid
invalidated
invasion
inventory
invoice
irrecoverable
irrespective
irrevocably

judicial
jurisdiction
justice

liable
liability
lien
lieu
limitations
livery
legal
legally qualified
lessee
location
loss

maintenance
malice
maliciously
maturity
mechanical
metacarpo phalangeal joint
miscellaneous
misrepresentation
misrepresented
misstatements
mortality
mortgage
mortgager
mutual

negotiable
negotiation
net
non-forfeiture
notify
non-negotiable
null

oath
occasional
occupation
occurrence
option
optional
ornamentation
overt

partial
participating
payment
pending
permissible
pilfer
pledged goods
policy
possessed
practicable
period
prearranged
precedent
prejudice
premise
premium
presentation
pretense

quarterly
quoted

rate
rebellion
reciprocal
reimburse
reinstatement
renewal
render
replevin
reservation
revocation
robbery
rupture

tender
termination
theft
thereof
thereto

umpire
unearned
unabsolved
unexpired
unconditional
usurped

valid
value
vandalism
vault
vehicle
vendee
verbal
verified
verminous
violation
virtue
void
voluntary
vouchers

waived
waiver
warranted
warranty
warrantee
watchman
witness

There are scores of others! In safe driving there is an element of arithmetic involved which has been recognized in the judgment of these junior high school people. Safe driving is important! Over twenty thousand persons were injured by automobiles during the first eleven months of this year in Chicago.

Seven hundred or more of these persons are dead and among them many school children. Through the cooperation of the Evanston Police Department motion pictures became a part of the mathematics class in the interest of safe driving and in these pictures were explained some of the mathematical concepts of controlling an automobile. In figure 10, you see the "directors" of the company escorting Officer Kenneth Dickinson to his car after a stimulating discussion in the classroom relating to the protection of life, limb, and property.

FIG. 10. Mathematics education gets help from the Police Department.

SUMMARY AND CONCLUSIONS

No doubt many will not agree with the procedures that are illustrated by this paper and it is correct to question that this procedure and others like it can teach all the mathematics required of junior high school people. This paper was intended to illustrate a human approach to mathematics and little has been said about the development of skills and accuracy in mastering the essential mathematical material. You must realize that this has not been overlooked; it is a part of the program as it has been for many years but with a different approach. We will also agree that a program of this kind may not

be functional with all groups and misunderstandings can easily arise unless the activities are carefully guided within the comprehension of the children. But also bear in mind that there is no intention to "soften" mathematics, but rather to offer stimulation to put more brain cells into operation by calling upon the application and comprehension of the concepts of the subject matter. In closing let us recall that frequently there is considerable criticism thrown at students for their failure to understand mathematics. We must realize that children today are more doubtful and more critical than ever before of the material that is handed to them in the classroom in the old conventional way. It may be that the children, living in situations more complex than ever before, have a perfect right to demand that their schooling be applied in a more comprehensive and functional manner. It is our primary hope that you will carry some of these thoughts with you, and whether or not you agree with any of the suggestions that have been made, go back to your classroom with an experimental attitude to find better ways to make mathematics in the junior high school alive, functional, and thorough. Mathematics is not on the way out—mathematics is really on the way in if it can be made functional, livable, and comprehensible.

A SIMPLE DEMONSTRATION SHOWING THE FUEL CONTENT OF FOOD

By Elmer G. Thumm
Langley High School, Pittsburgh, Pennsylvania

In teaching the fuel value of food it has been my experience that a demonstration of the fact that foods contain fuel is interesting and impressive as a supplement to a discussion.

Since food burns most rapidly and completely when it is dry in the presence of a rich supply of oxygen, I have found the following method for attaining this result simple and convenient.

The food is dried and broken into tiny particles. The seeds of beans, peas or any of the grains, nuts, sugar and bread are examples of fuel containing foods that may be used. Thoroughly mix the food to be burned with an equal amount of powdered potassium chlorate. Put the mixture in a porcelain dish and ignite.

The food will burn brilliantly and quickly. As the food burns, oxygen is freed from the remaining potassium chlorate in the mixture to further support the combustion of the fuel in the food to completion.

Before mixing the food and the oxygenating agent ($KClO_3$) I apply a flame to a small quantity of the potassium chlorate to prove that the potassium chlorate will not burn, so as to leave no doubt in the minds of the pupils regarding the source of the fuel when the mixture is ignited.

THE TEACHING OF ADVANCED SCIENCE USING THE DEMONSTRATION METHOD

By Charles S. Webb

Beaumont High School, St. Louis, Mo.

The title of this article may be misleading. This is not a report of an experiment in teaching advanced science. In the preface to *Senior Science* by Bush, Ptacek and Kovats, it is stated that this new course is not in any way intended to replace physics and chemistry; that it has drawn from these courses relatively few students; that it is primarily intended to furnish a text for those pupils who are following commercial, home economics, shop or general courses, pupils who are completing their formal education with their graduation from high school. With this purpose I am in hearty agreement.

The reasons for presenting this paper as an additional discussion of the new science are:

1. Many school administrators consider that this course does provide a satisfactory substitute for physics and chemistry.
2. Some State High School Inspectors, two that I know of, have stated that they regard this type of book as the coming thing in science for the junior and senior years. Both indicated that they regard physics and chemistry as no longer suitable for high schools and that they believe a new course of this type should be substituted.

I do not know whether this policy on the part of some school administrators is the result of the sales policy of the publisher, a too superficial consideration of the text by school executives and teachers or a sincere belief that an informational textbook course would be more successful than present methods. It is of course not impossible that the above belief may be correct; but until reliable tests have been devised to show whether the values believed to be inherent in science study can be achieved in some newer, easier way than those we have been accustomed to use, it seems hazardous to break too completely with present standards at least in the case of those students who desire and are capable of real scientific training. I believe that most of those present including the authors of *Senior Science* will agree that this tendency which we have been considering is, to such extent as it exists, unwise. The purpose of this paper, therefore is not to deny the important need that texts like *Senior Science* fill, but merely to propose the equally important need for

another text by some unknown and undiscovered author in the field of physics, and in chemistry as well; a text that will present these sciences in a way that will attract and intrigue boys and girls and yet be adequate for the regular standard course.

The criticism has been made that books of this type are not entitled to the name "Science." The present speaker is not in sympathy with this criticism. Science is organized knowledge. *Senior Science* certainly meets this test as do many texts in social science, political science, domestic science and other sciences. It is not, however, and does not claim to be, a course in physics and chemistry of the sort and extent that we have been accustomed to require of juniors and seniors in the high school in order to satisfy the requirements of college entrance and the standards of the North Central and other similar associations. Another and equally unjust criticism is that *Senior Science* teaches no more science than do the advertising brochures of the manufacturers of electric refrigerators, automobiles, vacuum sweepers, etc. This is not a fair statement. A better statement would be that *Senior Science* presents in well integrated fashion a very great deal about what science has accomplished and is accomplishing but with less relation to the principles of organized science than some of us would desire. And yet it would not be surprising if books of this character should point the way toward better physics and chemistry texts and attract a larger number of students to secure the benefit that science study should give.

This demand for a new physics to which *Senior Science* may perhaps be considered as one response can be traced to the growth in popularity of the demonstration method as against the student laboratory experiment method. Many and fervent have been the discussions regarding these two methods of teaching. Most of us believe there is too much of value in both methods to make it wise to discard either. As instances in point let us consider two examples; the first from visual education. It is generally agreed that there is much value in the use of slides, pictures, films as well as other devices in which the eyes perceive representations of things and phenomena which it is not feasible to observe in their reality. Some over enthusiastic advocates of this device envision a classroom of the future in which a talking motion picture projector will take the place of the teacher. No teacher will be present, but a student monitor

will take the attendance and turn on the machine. The demonstrations and explanations will be presented by the talking projector grinding out the discussions and illustrations as the hour speeds on, and thus the machine will eventually displace the teacher as it has displaced many another worker.

The second illustration is from the radio. The radio has been used as a supplement to the classroom in many useful ways. This instance seems in some respects unique. Mr. Carpenter in Rochester, New York has been giving a course in chemistry to students in their homes. I understand that this came about because a large number of students who wanted chemistry were unable to get it in the regular school program. Mr. Carpenter said if that number were anxious to study chemistry he would see that they had the chance. And so he used the radio to broadcast the instruction to the students in their homes. Examination of these students periodically, along with those who learned the subject regularly in school showed that the radio students learned their chemistry as well as those in the school classes. However, Mr. Carpenter did not just lecture on chemistry. He had the students procure materials and have the materials in front of them while they listened to the radio instruction. They did the things that he directed them to do with the materials; and thus he taught, and they learned chemistry very effectively. Of all teachers science people should be first to adopt scientific discoveries and adapt them to teaching purposes, but we should be slow to discard tried methods for untried fads.

At its best the demonstration method is certainly highly effective. The same can be said for individual and group experimentation.

I have used the word experimentation deliberately. If all the initiative and all of the planning comes from the teacher I doubt if it matters very much who handles the apparatus, and probably time and possibly money may be saved if we eliminate laboratory experiments by the students. But if and as we are able to promote student initiative and student planning of his experimentation, if more and more the laboratory can become the place to which the student comes eagerly to find answers to his own questions and work out his own ideas, then student laboratory experimentation will fill a place in the educative process that no other device can replace.

So we come back to the old truism that no one method can

bring about satisfactory progress in any field and least of all in science. And that is why it seems probable that books like *Senior Science*, while they undoubtedly represent a very valuable contribution to the teaching of physics and chemistry, are not adequate as a substitute for these sciences as training in scientific habits and methods and principles, or as meeting college entrance requirements and North Central and other similar standards.

The growth of the demonstration method as a substitute for individual experiment was accelerated by the depression, during which time funds for operating the schools were much reduced. It was argued that if the course in science be given by demonstration, only one set of apparatus need be procured; whereas if it were given by student individual or group experiments a considerable number of duplicate sets must be purchased. If equally good work can be done by either method, why not save the extra expense? If we grant this last assumption, the reasoning seems sound up to the point where we assume that the same set of apparatus will serve in either case. It is my observation that the numbers in science classes range from 12 to 40, and it is, I think, quite obvious that students sitting in the back rows of such classes will have difficulty in seeing what the teacher is doing in such experiments as the following which are typical of scores of experiments in physics and chemistry:

1. Producing droplets of mercury along the sides of a test tube when mercury oxide is in the bottom of the test tube and is being heated over a flame.

2. Showing direction and magnitude of the deflection of a compass under the wires of a galvanoscope when a current is passed through the coils.

3. Showing the current generated when a St. Louis motor is connected to a galvanometer of either the flat or the inclined type and the armature is spun.

Many, very many other illustrations could be cited. It is impossible for the student to see clearly what is going on while the teacher is demonstrating with these small pieces. The only solution is to have a very different sort of apparatus when the entire class of 20 or more must observe the experiment done by the teacher. In the last mentioned demonstration a galvanometer of considerable size that really can be seen all over the class is needed, and a motor or dynamo of a form and size such

as the Cowan apparatus which is sufficiently large for all to see. Such pieces cost a good many times as much as the simpler pieces. Thus if the course is given by demonstration in a satisfactory way it is not less expensive, but rather it will result in a larger expenditure than is usually necessary with the older method of student experiments. If the students do not see what is going on the instruction may be no more effective than a phonograph record, and the result may be not as good as with the talking motion picture without any teacher.

It is the thought of the author of this paper, and he believes that agreement on this point is rather general, that science instruction to meet satisfactory standards must be rich in experimental work either by the teacher or by the students individually or in groups. Teaching scientific methods and principles without such illustrative and enlivening activities would be like trying to describe the glory of a sunset to one who had been blind from birth. Imagine trying to visualize the wonderful phenomena of a cell dividing and reproducing itself merely from oral or verbal description without ever having the chance to really see this wonder through a microscope. As well try to learn a foreign language without ever pronouncing the words or to learn to play the piano without ever touching the keys. Of course we are not chiefly concerned with teaching skills, but we are greatly interested in teaching principles and habits of thought. Studies in education indicate that educative effort should be directed mainly toward emphasizing principles; that while informational details are likely to be forgotten, principles have a better chance of being remembered.

It is our contention that before *Senior Science* and similar texts can take the place of physics or chemistry, it must be enriched with forceful demonstrations to teach principles. Perhaps a teacher inspired with the idea of enriching this course with experiments and demonstrations could take a class through a course in *Senior Science* and teach principles and methods, as well as the applications which are so excellently presented in the book, and get superior results.

With this idea in view we have taken the book, *Senior Science*, and have gone through the pages with the idea of introducing such demonstrations, and have come to the conclusion that if these demonstrations be given, teaching the principles as outlined in this book in a way that would satisfy universities and the North Central requirements, the demonstration ap-

paratus would cost in excess of $750.00. Bear in mind it is not claimed that all this demonstration apparatus is needed to teach Bush, Ptacek and Kovats' book according to the purpose outlined in the preface. But such demonstration apparatus would most certainly be required if this textbook were intended to be taught in a manner that would give the students a knowledge of principles sufficient that it might be substituted for the standard course in physics and chemistry.

The science curriculum in high school probably needs two courses.

1. *Senior Science* or some similar course for those students "who would not otherwise take physics or chemistry and who may be completing their formal education by graduation from high school" and

2. A new physics and a new chemistry for the regular course to meet college entrance and North Central Association and other requirements. Perhaps the best method of making these proposed new courses a reality can be outlined as follows:

First: Enrich the course by ample demonstration. If given without student experiments, the demonstrations should be multiplied so as to include at least as many demonstrations as have been eliminated by omitting individual experiments—and with larger, more expensive set-ups. The following is from a proposed course of study in science in one of the Mississippi Valley states. It is given as "proposed" because, while the writer has seen the original copy, it has not as yet been published. In this course of study it is stated as follows: "If this science is given as a demonstration course, the teachers should give at least all of the same series of experiments as might be required in the course if given as a student laboratory course. If such a program of experimental work is not followed, the course will become a textbook course and be on the order of nature study more suited to elementary schools than high schools. No matter which method is followed, the teacher should give ample additional demonstrations with larger pieces." Another course of study by another of the Mississippi valley states, has in the copy as it is now being prepared, an outline of two courses in physics and two in chemistry. One of these is called the "standard course" or "academic course" or "regular course" with seven periods per week including a double period twice a week for student experiments. The other course is the "reading" course, requiring only five periods per

week with only teacher's demonstrations and group demonstrations. An interesting comment in this course of study is the following: "Whether such a course will be recognized by accrediting agencies for a unit of credit has not been considered."

Second: We must have teachers that have been trained to give more and better demonstrations. It is indeed easier to conduct a class by assigning a certain number of pages of text, and sitting at a teacher's desk asking questions of the class as to what the paragraphs on those pages had in them. It is only the very unusual teacher that enriches his course voluntarily with demonstrations. It is only by aid of textbooks that many demonstrations are urged upon the teacher. It is the clear duty of the colleges and normal schools to put into their teacher training program such courses as "The teaching of physics," "Physical Manipulation," and other courses teaching how to set up and handle equipment effectively. The University of Georgia has recently done much along this line.

Third: A new text is needed to fit this new course in physics and chemistry. As far as the speaker's knowledge extends the only attempt to do this has been in the two books written by Mr. Sherman R. Wilson of Northwestern High School of Detroit and published by Henry Holt and Company. He has prepared two books, one called *Descriptive Chemistry* and the other called *Descriptive Physics*. The *Descriptive Chemistry* is very good. The *Descriptive Physics* is only a small book of some 230 pages and I am told that it was referred back to him to rewrite before the Detroit schools would use it, because he had omitted such a very important subject as levers. This list of omissions may be extended materially. In fact there is little or nothing in the *Descriptive Physics* by Wilson about pulleys, the inclined plane, laws of the pendulum, inertia, centrifugal force, Newton's laws of motion, parallel and nonparallel forces, Boyle's law, calorimetry Charles' law, diffraction, polarization, etc. Bear in mind the book is only 230 pages while Bush, Ptacek and Kovats' book contains 834 pages of a larger page size and a smaller type. It should easily be possible to rewrite *Descriptive Physics* in the form in which Mr. Wilson has put it so as to include all of the things which have been omitted, and to put it in the way in which he has put it. Mr. Wilson has included in his book much that will stimulate the teachers to do demonstration. The very first pages include the well known diffusion of molecules through a porous cup, and from that he leads to

carburetion in an automobile. This is an excellent way to attack the subject of molecular physics. Mr. Wilson states in his preface that "this book does not meet all the requirements for college entrance." Would it not be possible to add a number of pages and include the subject matter omitted and have it illustrated by the teacher by the use of largely clearly visible demonstrations so as to acquaint the student with a more comprehensive account of the subject in such a way that it would meet college entrance requirements? Such a text would be heartily welcomed. If properly written and especially if generously supplemented with appropriate and forceful demonstrations using sufficiently large and easily visible apparatus, it would undoubtedly meet college entrance requirements because it could easily include the teaching of all the principles of physics regularly covered in the high school course.

In this connection I am sure that every progressive teacher of physics and chemistry will be interested in that new forthcoming and soon to be published book which will describe a large number of demonstrations. These were selected by asking teachers all over the country what one or more demonstrations were in their opinion most effective and useful in their work. We look forward to this book with a great deal of eagerness. Modern catalogs of the leading manufacturers of laboratory apparatus constitute one of the most useful sources of information about demonstration apparatus that is now available to science teachers.

In conclusion it may be said that physics and chemistry are not in their death throes. As evidence in support of this claim consult the table on page 20 of *School Life*, a publication of the United States Department of the Interior, and note that the enrollment in physics increased 43% from the year 1928 to 1934, and in chemistry it increased 67%. In addition call to mind that there are innumerable courses of study of science in the grades. There are quite a number of states that have published courses of study that require science in every grade beginning with the primary. Typical eastern states are New Jersey, Maryland, and New York; typical western states are Iowa, Nebraska and Colorado. Science, so far from dying out is coming upon us in a great way.

It seems probable, however, that important changes in method and content are imminent. Some of these changes are probably desirable. They should be welcomed and tested with-

out prejudice and not opposed merely because they fail to follow traditional patterns. It seems likely that these changes will develop along two lines to meet two different needs. One course will be informational in character to acquaint the student with the results of scientific progress and will be designed chiefly for students who are not likely to go on to college. The other will be designed for those who need a thorough grounding in scientific methods and principles. To these ends new texts are likely to be demanded, texts which will combine with the attractiveness and appeal of our popular scientific magazines the basic principles and training in scientific method of the standard courses. They must present the subject matter with a wealth of illustrative material of all sorts and from a great variety of sources; effective and numerous demonstrations, motion pictures, current literature, and especially real student experimentation, self motivated and as far as possible, self directed as all real experimentation is.

ARE YOU CROSS AT CROSS-HAIRS?

By H. Lynn Bloxom
High School, Fort Dodge, Iowa

Occasionally in the laboratory it is desired to improvise cross-hairs in a telescope not already equipped with them, or to make a hasty repair in order to complete some urgent readings.

Seldom is the ordinary laboratory stocked in a way to make this seemingly delicate operation a desirable undertaking. Yet one may speedily make a substitution that will pass—on first inspection—for the work of an equipped artisan, with very common materials.

To do this, a drop of glue (Le Page's, for instance) is allowed to stiffen slightly, then the point of a needle is touched to the glue. A small bead adheres and this is touched to the edge of the circle that defines the field in the focal plane of the telescope lens. As the needle is drawn away, a thin thread is formed which hardens by evaporation. By one bold, deliberate movement this thread may be stretched across the field, and attached to the opposite edge by touching the needle to the metal. The needle should be continued in the same direction as it is drawn away. Another thread drawn at right angles completes the job.

It is necessary to have glue of the right consistency. A little experimentation and practice will show the way. Threads of glue are fragile when dry and yielding when moist, so it is necessary to assemble the telescope with care. Otherwise, the hairs may be blown away even by collapsing the telescope.

Filaments of other dissolved materials may be formed by similar technic, with varying difficulty, and the results may in some cases be generally better and more lasting. Rubber cement gives larger threads which are sometimes desired, but they show a tendency to collect dust.

FORESTS AND FLOODS

By Stanley F. Wilson
Associate Regional Forester, Milwaukee, Wis.

Introduction

Out in New Mexico there lived an old prospector who was quite a character in the country. When the main highway was put through past his formerly isolated mining claim, he decided that he ought to have something to sell to the people traveling by; so he hauled water in from a spring seven miles away and sold water to travelers for ten cents. If you wanted to drink, if you wanted to water your horse, if you wanted to fill your canteen, or if you wanted to fill your radiator, the cost was ten cents. One day an Easterner stopped his car to get some water and was tremendously shocked at the idea of paying for it. He was surprised that the prospector hauled the water seven miles and asked him why he didn't dig a well. The prospector said that it was just as far to water that way and lots harder work. The Easterner stormed around, becoming more and more eloquent, and finally stated that water was the free gift of God and that it was ridiculous to think of paying for it. The prospector was getting a little impatient and answered that if the Easterner went up the tortuous trail to the spring seven miles away, God would give him water, but that if he got it there on the road, it was going to cost him ten cents.

It is true enough that water is the free gift of God, but it is also true that it may be made a curse rather than a blessing. This is what I want to talk about.

My subject, as announced, is "Forests and Floods." I expect to add to this, however, and talk on forests, floods, and erosion, since erosion is so intimately tied in with floods and with the lack of vegetation.

I came to the North Central Region a year and a half ago after more than twenty years spent in the Forest Service in Arizona and New Mexico. I was, however, born and raised right here in Cincinnati and was educated here and in the East, so that the question of floods in the eastern half of the United States has been before me a good deal. On top of that, the relationships between forests and floods were still further emphasized to me in the Southwest where the balance between vegetation and the lack of it is more precarious than it is here.

Recent Floods

The North Central Region of the U. S. Forest Service takes in the States of Michigan, Wisconsin, Minnesota, North Dakota, Iowa, Missouri, Illinois, Indiana and Ohio. It happened that last spring I was in southern Illinois and in Cincinnati at the beginning of the flood period and was back on the Shawnee Forest in southern Illinois as the flood waters were subsiding.

In Cincinnati the maximum river stage reached was 79.99 feet—this against a previous high water mark of 71 feet in 1889. In southern Illinois the previous high mark had been in 1913, but it was far surpassed by conditions last spring, and houses, roads and fields, formerly considered entirely safe from floods were inundated.

The Situation

Gifford Pinchot said recently: "A flood is like an epidemic. The time to stop it is before it begins." Up to this time we have been building engineering works to take care of the floods after they occur, but we have done practically nothing to prevent floods from occurring or to reduce their height and destructiveness when they do take place. The engineering works on the lower rivers are absolutely necessary, and most foresters appreciate this, but certainly most of us should realize today that engineering works alone are not enough.

There were floods in this country before settlement by the white men, and undoubtedly there always will be floods. But the floods seem to be getting worse. They are worse, not only because they are higher but because there are more people to suffer and more property to be destroyed, and also because of the vast amount of silt carried suspended in the flood waters, which, besides increasing the volume of the flood, makes it much more destructive because of the abrasive power of the material carried in suspension. *This last factor is one great difference between floods now and those previous to white occupation.* Before we began to abuse and destroy our natural resources, the streams kept fairly clear, even in flood time. The soil was protected and kept porous and absorbent by the forests and by various kinds of vegetation. There was very little exposed ground and so the enormous mass of soil and sand now carried by our rivers in flood remained where it belonged.

In this connection, I was interested in a statement which somebody recently made to the effect that the Ohio Valley flood

was more serious because the January rains fell on unfrozen soil. What does this mean? Merely that if the soil had been frozen, it would not have been eroded and carried off to swell the volume of the flood and increase its destructive force. The original vegetative cover protected the land much more dependably than will a chance freeze.

Since our settlement of the land we have cut, burned, overgrazed, cleared and plowed so unwisely that we have exposed our soil to destructive erosion which for years has been picking up and carrying away the richness of our land.

Not only is the soil carried from where it is needed, but it is made a destructive weapon. Every ton of earth that is washed into the tributaries of a river in flood increases the height, weight and destructiveness of the waters. It has been estimated that every year the rain washes into our rivers, and our rivers carry to the sea, more than a billion tons of soil—eight tons each year for every man, woman and child in America. These tons of soil become files and chisels and battering rams driven by the power of the stream. Nobody knows how much they add to the height or the damage of the flood.

I was told at the Coast Guard station in Milwaukee this summer that boats and crews from there were sent to the flood zone above Cairo in February. It was stated that the biggest boat they took down was of no use in this service because of lack of power. It could not buck the current, which reached a velocity of sixteen miles per hour. Imagine the abrasive force of water and sediment in a current like that.

The flood damage, great as it is, is not the only loss. The loss of fertile soil is the greatest loss of all and the most permanent. Professor T. C. Chamberlain has estimated that it takes ten thousand years to reproduce a foot of the soil we have been wasting. Already a quarter of it is gone. When our soils are gone, we too must go.

Unchecked erosion means losses to everybody. The uplands lose and the lowlands lose. What made up the wealth of fields and forests higher up, becomes an agency for destruction lower down.

Thirty years ago the Inland Waterways Commission pointed out that every river is a unit from its source to its mouth and must be treated as such, and urged headwater as well as lower stream control. It would seem axiomatic that merely confining the rivers lower down would be insufficient.

There is no mystery about what else is required. We need to stop forest devastation at the headwaters. To do that we must control logging and fires. We need to replant or to protect the natural regrowth on lands not suited to farming. We need contour plowing of our farm land to prevent the carrying off of soil. We need to prevent overgrazing. We must control and repair erosion that is already under way.

I noticed a recent estimate indicating that the last flood would have been at least ten per cent less in volume if the existing woodlands had been in optimum condition. The basis of the estimate was as follows:

(1) The 37% of the Ohio Basin which is woodland, probably received 37% of the precipitation or which caused the recent flood.
(2) Woodlands in optimum condition would probably have contributed only one-half as much run-off per acre during the flood period as non-woodlands.
(3) Forest fires, grazing, timber cutting, etc., have probably reduced the forests to an average of 50% efficiency in holding back flood run-off.

It is estimated then that the run-off in the recent flood period was at least 10% greater than it would have been if the woodlands had been in optimum watershed condition.

I consider this estimate very conservative. It doesn't take into account at all the silt which further increased the volume of the flood, besides making it more greatly destructive. It likewise doesn't consider that perhaps larger areas of poor land should be wooded or covered with some kind of protective vegetation.

Forest Relationships

I wish to discuss forest relationships for a little while.

The forests and woodlands provide cover and litter. The roots of the trees and of the other vegetation tend to hold the soil in place. Leaves and branches act as a mechanical protection for the soil underneath and the decaying matter makes the soil more porous and sponge-like so that water may be absorbed instead of going off in a destructive rush. In the Southwest, overgrazing has been the great devastator and most of the troubles from destructive erosion and dust storms hark back to the abuse of the grass country. Here in the Middle West, most of our difficulties are from deforestation, farming of sub-

marginal lands which might better be in woodlands, poor farming methods, and fire.

Experiments have been made in California, in Utah and in other places, comparing destructive run-off from small watersheds having adequate vegetative cover with that from watersheds similar in area, slope, etc., but having recently been burned over. The results have consistently shown the same trends. More water, carrying more debris has come off the denuded areas in shorter periods. In some cases the comparisons showed the extremes of tremendously destructive torrents from denuded areas, contrasted with slow seepage of clear water from forested areas. I believe that even foresters have been too slow to accept these results. It is true that we have no detailed and accurate conclusions covering large drainages, but most of us who care to observe them have noted many cases of the absorptive effect of ground covered with vegetation as contrasted with that of bare soil.

We must get our forest lands back into forest cover. A significant thing which has has struck me in the Lake States is that the bad fires are in devastated areas. In the virgin forests there is more moisture and less wind and fires are much easier to keep out and to control. Once our areas are back in productive form, our fire worries will be greatly minimized.

In the States you people are most interested in, the problem is different. In Missouri, we have a tremendous incendiary fire problem. Last year we had 2869 fires of which all but 4 were man-caused. This year to November 10, there has been a total of 853 fires—with 3 of them not man-caused. Tied up with the fire problem is the grazing problem. Within our purchase units, ten thousand people own some thirty thousand head of stock. The country is being impoverished and ruined by overcutting, by repeated fire and by over-grazing.

In Ohio, Indiana and Illinois the setting of fires is not so prevalent, but fires are allowed to burn and woodlands are grazed and overcut.

Forest Service Planting

During 1936, 215 million trees were planted by the Forest Service. This exceeds the 1935 previous all-time high by more than sixty per cent.

Ninety per cent of the planting was done in the Lake States and in the South.

Region Nine planted 140 million trees on 141,478 acres (or 65% of the total planting). In the South, 55 million trees were planted.

Michigan planted 78 million trees.

Wisconsin planted 40 million trees.

Louisiana planted 22 million trees.

Mississippi planted 22 million trees.

In the Ohio Valley States we don't know very much about reforestation and most of our planting work so far has been on an experimental basis.

In 1937 we planted 3100 acres in Missouri, 2900 in Illinois, 340 in Indiana, and 240 in Ohio. The species were mostly shortleaf pine, red pine, black locust and yellow poplar.

Land Acquisition

In connection with the planting program, we come naturally to the subject of land acquisition—the securing of those lands within our Forests and Purchase Units which should be retained in forest cover.

Some Statistics for Reference

State	Gross Area	Govt. Land plus Area Purchased	Yet to be Acquired	Money Needed to Complete Program (Estimated)
Illinois	786,832	152,850	503,964	3,527,748
Indiana	781,296	34,471	471,776	3,774,208
Iowa	829,016	100	508,793	5,596,723
Michigan	5,136,582	1,691,965	2,494,552	11,225,484
Minnesota	5,053,960	2,254,886	1,384,652	4,500,119
Missouri	3,321,365	1,019,375	1,738,447	5,215,341
North Dakota	764,441	480	499,520	1,998,080
Ohio	1,465,948	38,194	1,061,806	8,494,448
Wisconsin	2,016,226	1,294,917	294,995	958,734
Totals	20,165,666*	6,487,238	8,958,505	45,290,885

* 4,719,923 acres of gross area considered non-purchasable for public forestry purposes; used for agriculture, developed recreation and virgin timber stands.

The North Central Region was established January 1, 1929. Because there was little Government-owned public domain land remaining at that time, a public acquisition program was

started under the Weeks Law of March 1, 1911, and the Clarke-McNary Law of June 7, 1924. Both of these Acts authorize the purchase of land by the United States Government on watersheds for flood control purposes and also for reforestation and timber production in States which agree to it by passing enabling acts.

At the outset, the work in this Region was wholly confined to the three Lake States, but was expanded, beginning in 1933 (Ohio and Indiana, January 1935), to take in the Central and Upper Mississippi States.

The purchase program of the Region is but 42 per cent completed. Perhaps these figures may offer some food for thought.

MICHIGAN SCHOOLMASTERS' CLUB

At its annual meeting held Saturday, May 1, 1937, at Ann Arbor, Michigan, The Science Section of the Michigan Schoolmasters' Club, composed of teachers of science in high schools, universities, and colleges throughout southern Michigan, formulated the following statement:

The Science Section of the Michigan Schoolmasters' Club views with great concern the apparently increasing tendency manifest in many high schools toward diminishing or even eliminating individual laboratory work in connection with various courses in science, particularly those planned for the dull-normal pupils. Because of the weight of investigational evidence which establishes beyond doubt positive and unique values derived by the pupil from engaging in individual laboratory work, the Science Section believes that the elimination of individual laboratory work is unjustified on any sound psychological or pedagogical grounds. It therefore voices its unanimous and unqualified recommendation that some individual laboratory work[1] be made an integral part of every course in science offered at the high school level, whatever the nature of the course may be.

Signed,

FRANCIS D. CURTIS, *Chairman*
University of Michigan
FLOYD I. LEIB, *Secretary*
Michigan State Normal College

[1] By individual laboratory work the Science Section means work in which the pupils actually engage in the solution of laboratory problems individually and not in pairs or in groups.

ELASTIC METAL

Development of an "elastic metal" composed of a mixture of steel and soft rubber has been reported at Berlin.

Unusual elastic properties, useful in springs and shock absorbers, as well as high sound-absorbing qualities, are claimed for the new discovery.

FIRST YEARS IN SCIENCE—WHAT ARE THE GOALS?

By Bertha Stevens

Avery Coonley School, Downers Grove, Illinois

The first years are here considered to cover the span from the kindergarten through the third grade—which is equivalent to citing the school ages below nine. Children below the ages of seven or eight, according to my view, are adapted to nature observation and experience, coupled with information in so far as they ask for it, rather than to any sort of group-plan nature or science study.

In the first years it is important, I believe, to promote: (1) The concept of nature as one whole. (2) Direct, actual, tangible relations with nature. The study of science, which is systematized knowledge of nature, needs such foundation. This second goal can be attained in a measure from kindergarten up. (3) An experience of nature and science that involves the child's emotions, his intellect, his imagination and his initiative. In the discussion of these three major points I shall refer to some lesser goals related to or inherent in the major ones.

It was in 1934 that Jeans wrote in his book-of-the-year, *The New Background of Science*, "Science is only just entering upon its latest and most comprehensive problem—the study of the Universe as a single entity. . . . The different sciences have each drawn their own pictures of small fragments of nature which form their special objects of study, and we now find that these fragmentary pictures piece together to form a consistent whole."

And so it comes about, in recent years, that we see book titles such as *The Borderland of Astronomy and Geology, From Atoms to Stars, Atom and Kosmos, The World, Radio and the Stars, The Universe and Man;* and, in 1936, we have Dr. Alexis Carrel in *Man, the Unknown* calling for super-scientists who shall assimilate all branches of scientific knowledge, and build up a working synthesis. This is enough illustration to suggest that to-day's trend in science is toward wholeness and unity in concept.

There is a reflection of this trend in the breaking down of compartments in the teaching of science in elementary and secondary schools. If nature is a unit, and not a miscellany, it is to be expected that information of any natural phenomenon —or object, or explanation of any process based on the operation of nature, if in any sense complete, will cross the bound-

aries of several so-called separate sciences. The parts which make nature's whole are inter-related, interdependent, as we know, and they obey the same laws. In different "realms" of nature identities and continuities may be found. Thus, seeing nature whole, thinking of it that way, accepting literally the meaning of the term universe, is the first necessity for the primary science teacher, and the first necessity for children whose development is equal to it. I think this point of development is reached normally in the third grade year.

When children's thoughts have travelled beyond their world out into space, when they have gained some conception of the universe picture or pattern which science supplies, and they are clear in their thinking about the assigned place of the earth and man, in space and time, they are oriented in a way that is important to their present and future thinking.

If, as they proceed to observe and learn about nature in its tangible, concrete aspects in their daily life and environment, they are helped to discover and recognize fundamental concepts common to nature-in-general, their science program is assured of meaning, vitality, motivation. Once children get the idea of what to look for, they can rediscover for themselves illustrations of sequences, cycles, conservation; the pervasiveness of orderliness, organization, form and design, rhythm, and beauty. If experience uncovers the operation of a force, they can watch for this same force in realms other than the one which revealed it to them. Holding the concept of nature as one consistent whole touches children's imagination and awakens, extends and deepens their thinking. They begin to look for the idea, or principle, back of the tangible, or at least concrete, fact.

Recent texts and general-reading books for children in the elementary science field are taking account of this concept of wholeness, in their organization and content. Further, and this is a digression, there is a tendency now for the writers of such books to trust nature and to trust children more than writers in this field used to do. Statement tends to be more direct, without—as we say—"talking down" to children. It seems to be realized that children, even little ones, can take their science straight—if they are ready to take it at all; and without the aid of an Uncle John and a thread of story, or of animals and even inanimate objects made to talk and react as if they were human. We have, to a great extent, outgrown these books; but it is

unfortunate that some of the good, new publications are now being written with a journalistic use of intentionally "catchy" phrases and a forced buoyancy and briskness of style. This effort for interest is not needed, I know; and the quality of it is foreign to the quality of science and nature. We are getting now a greater proportion of books for children written—or checked—by authorities in the specific field these books cover; and, of course, we should have no other kind, if the purpose is information.

What content can we give children in the first years of science that is able to promote the concept of nature as one whole? For the earthborn, the earth-ball is the starting place in such thinking. We can, in the first place, help children really to conceive the earth as a ball. For, while most third grade children have heard that this is true, very few of them have thought the matter through and actually accepted it. When they do reach that point of thinking, the conception necessitates that the ball be somewhere—and logic eventually, inevitably, puts it in space. Having gained the idea of the earth in space, it is easy for children to pass on to information of the earth's relation to other bodies in space, and to include theories of the earth's, and other planets', beginning.

So effortlessly does one reach with children mental receptivity for a scientifically true, though general, statement regarding the known or assumed universe, and the celestial bodies which compose it. Astronomical figures convey practically no meaning to children—in fact, very little to most adults. But enough can be stated or shown to give children, at this point of learning, the positive idea that science accepts for the universe, as a whole, exceedingly great numbers, magnitudes, distances, and ages—if our own world's size and age be taken as the unit upon which these comparisons rest.

Information about the earth in space and its relations is summed up, in my teaching, in what is called "Star Study." I like to start with this, with a new group of third grade children, not only because it supplies background or framework for what follows, but because it seems to have special power to start independent, detached thinking, and to bring out qualities of wonder and reverence, in thinking; and it easily supplies a list of fundamental concepts with which the succeeding studies of earth science, plants and animals can be checked. Moreover, the great changes that ten years have brought about in the

science of astronomy can be utilized to show, or illustrate, to children that neither nature nor knowledge is stationary.

What I have to say with regard to the way of presenting information can be summed up in a plea that children's introductory experience be unhurried. They need to have feelings before gaining facts. They need to have time to react to the thing they will study about—time to revel in its beauty, to be arrested by its form or its movement. They need time to use instruments of exploration—magnifiers and flashlights to aid seeing; magnets and other tools, for discovering or working with forces and laws. They need opportunity to play with what is before them, to try it in various combinations and under various circumstances; to show each other what they find, and to cooperate in their discovering. They need time to explore and reach conclusions, even though conclusions are sometimes wrong ones that have to be corrected; and their thoughts should have time to wander to appreciations and meanings which a cursory glance would not find.

Wonder, happiness, and steady, absorbed interest are legitimate factors of children's scientific experience, though stimulation, thrills, and peaks of interest transiently occupied are not legitimate; and neither is idle fooling.

When children have had unhurried opportunity to play with nature or science materials, just observing and turning over the experience in their minds, they are likely—I might say sure—to reach the point of wanting information; and at that point they should have facts to the limit of their ability to receive them, no matter where they lead. It seems to be true that when children reach slowly, but thoughtfully, the point of asking for facts, they are able to grasp essential ideas which these facts involve—even though the ideas may be of a type commonly associated with maturer years.

There is certainly no reason to push children in early years, and certainly every reason to let them be child-like. But it is probably true that many a teacher has never discovered the high level of intelligence of the children she worked with, because she set an artificial limit upon their ability to think and reflect.

An unhurried introduction to science does not imply lack of accomplishment or definite aim. I believe the accomplishment, in children's development and in the acquirement of knowledge, can be greater because of it. The teacher will need to have in

mind at all times, in broad outline, the essential content for the year, and the objectives to be reached through it; and she will need to provide the environment and experiences from which these can evolve.

An unhurried introduction to science has implications for an elementary school's staff organization and its curriculum. To one who agrees with the foregoing statements about the way of presenting experience, it may seem obvious that the classroom teacher, rather than the departmental science specialist, should guide children through their start in science. The specialist who meets the class at intervals, and for relatively short periods, may be practically forced into a program of progress which runs ahead of the children's readiness for it. However, it is likely to be true that, in any group, certain particularly thoughtful, intelligent children will need to carry some individual problem or inquiry to the science room and the special science teacher.

The home-room, over which the classroom teacher presides, can and should—in materials and creative expressions—reflect the contemporaneous science experience; and in this room there can be time and opportunity for children to share and interpret their work to guests or others who may desire this.

When the classroom teacher is in charge of the science work, the children (and little children need this) can have a daily exchange with her about it—to show something they have brought in, to say something they have thought, or to report something seen.

If the introductory science experience is as engrossing as it should be, there will not be time in the school day, or room in a child's mind, for another engrossing content—such as a big project in transportation, community life, or Indians. I believe that the year in which children first bring developed thinking to science experience, can well be devoted primarily to this one vital interest, with its cultural ramifications.

A NEW MEMBER OF THE "ON" FAMILY

The discovery of a new sub-atomic particle heads the list of 1937 achievements in physics and chemistry.

The new particle, yet unnamed and without a niche in the structure of atomic physics, is intermediate between the electron and the proton. It appears to possess either a positive or negative electrical charge and preliminary determinations of its mass placed it at about 150 times the mass of the electron.

MATHEMATICS AND SCIENCE

By Charles N. Moore
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The origins of mathematics and science are lost in the mists of antiquity. As far back, however, as it has been possible for historians in these fields to trace the records, it has been found that science in general and mathematics in particular have undergone a simultaneous and parallel development. A little reflection will convince any thoughtful person why this must have been the case. It is quite apparent that astronomy, one of the earliest fields to attain what may properly be called a scientific form, could not have been seriously advanced without the assistance of a well developed mathematical apparatus. Even the most descriptive form of scientific development in other fields could hardly have had its inception without making use of counting and calculation. It is well to recall that these elementary phases of mathematics, now become a matter of pure routine, were, in the infancy of the subject, mathematical discoveries of a very high order.

The usefulness of mathematics in other fields has sometimes led superficial observers to urge that mathematicians as a class should devote their time exclusively to problems which are of immediate concern to other scientists. Without touching on the question as to whether or not it is beneath the dignity of mathematics to play the role of a glorified valet to the other sciences, the whole history of mathematics and science shows that from a purely utilitarian standpoint this course would be eminently shortsighted.

The notion of number undoubtedly had its beginning in man's sense perceptions; the conception of a number as a purely abstract idea, however, was a great triumph of creative imagination and paved the way for much of the vast development of mathematical theory. The operation of counting was closely associated with practical needs, if in fact it did not originate from them. All the fundamental operations of elementary arithmetic can be reduced to a question of counting, if we restrict ourselves to the positive integers in connection with which they arose. When, however, these operations were examined as independent processes, the investigations eventually resulted in a very extensive elaboration of the number class. We find illustrated here one of the most important procedures that lead to

mathematical growth; namely a synthetic process followed by an analytic process. We synthesize a large number of related ideas into a more general idea for the purpose of economy of thought and economy of procedure. Then we analyze the more general idea for all its ultimate implications, and lo and behold a host of new ideas is found to be contained in our generalization. It has very much the appearance of rabbits tumbling out of a magician's hat, but here there is no hocus pocus. Creative imagination and strenuous intellectual labor have succeeded in enriching our stock of mathematical ideas.

The process of growth to which we have referred is again illustrated in striking fashion in the passage from arithmetic to algebra. The first synthesis of various arithmetical operations into an algebraic formula goes back into the prehistoric period of mathematics, for we find such a synthesis appearing in the earliest known mathematical writings. It could not have been said to have been properly completed, however, until our modern algebraic notation took form. From that time on the analysis of algebraic operations, which had already been carried forward to a considerable degree, grew apace. We have the so-called imaginary and complex numbers appearing first as purely formal solutions of certain types of algebraic equations, then being recognized as independent entities and given a concrete geometric representation, finally being assimilated into a complete number system and forming the basis of a beautiful mathematical theory with wide ramifications, namely the theory of functions of a complex variable. It is well known that for some time past this theory has found extensive applications in many branches of mathematical physics. In the recently created spinor analysis complex numbers seem to enter in some essential manner, rather than merely as a tool, as Veblen has recently pointed out.[1] Does anyone believe that mathematicians would have arrived at the notion of complex numbers, to say nothing of extensive theories concerning them, if they had confined themselves to problems having immediate practical applications?

The failure of the methods of solution which had been effective for quadratic, cubic, and biquadratic equations to yield similar success in the case of quintic equations led finally to Abel's brilliant discovery of the impossibility of such success. A systematic analysis of algebraic equations of higher degree

[1] Oswald Veblen, "Spinors," *Science*, Vol. 80, pp. 415–419, 1934.

at the hands of Galois led to the notion of groups of transformations. Thus we see emerging the basic ideas which are at the foundation of the theory of groups. In the present century we find far-reaching applications of this theory in the field of mathematical physics by Weyl, Wigner, and others.[2] The consideration of sets of linear algebraic equations led first to the notion of a matrix and then by the natural laws of mathematical growth to a comprehensive theory of matrices, including infinite matrices. Quite recently this general matrix theory has been of important service to Heisenberg and other mathematical physicists. It is difficult to see how either group theory or matrix theory could have been evolved by mathematicians who were concentrating their attention exclusively on problems with an immediate physical significance. The mathematicians have created these theories in what seems to have been the only possible way, namely by developing the science of mathematics along its own inherent lines of growth.

The postulates of Euclid represent the ultimate step in the Greek synthesis of geometric ideas and relationships. On these postulates as a basis a comprehensive geometric theory was elaborated by purely logical processes. An important part of this theory dealt with the curves known as conic sections. Thus an extensive knowledge of the geometric properties of these curves was attained by mathematicians who were advancing their subject in the manner its own nature demanded and not merely for the applications. Centuries later the astronomer Kepler found that the theory of conic sections was precisely what he needed to develop the laws of planetary motion.

The substantial completion of the synthetic operation involved in developing an effective algebraic notation paved the way for the next great step in the development of mathematics. This was the synthesis of algebra and geometry as then known into the analytic geometry of Descartes. This noteworthy advance is usually regarded as the beginning of modern mathematics, and certainly the growth of mathematical theory was enormously stimulated by it. Although this discovery is something less than three hundred years old, it has now so penetrated the thinking of the whole literate group that the newspapers of the day do not hesitate to use graphical representation.

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[2] Herman Weyl, "Gruppentheorie und Quantenmechanik," Leipzig, 1928, 1931 (English translation of 2nd edition by H. P. Robertson). Eugen Wigner, "Gruppentheorie und ihre Anwendung auf die Quantenmechanik der Atomspektren," Braunschweig, 1931.

The basic ideas of the differential calculus and the integral calculus developed in somewhat closer touch with the applications than in the case of many other mathematical theories. However, the recognition by Newton and Leibniz of the close relationship between the two methods of investigation and the binding link between their fundamental concepts ranks among the most brilliant mathematical syntheses due to individual effort. This synthesis having been made, the subsequent analysis resulted in forging the most powerful method of mathematical investigation which has yet been known. The calculus thus established enabled Newton to substantiate his theory of gravitation by deducing Kepler's laws from it, and his successors during the next two centuries to develop a comprehensive and majestic theory of the motions of the heavenly bodies.

In connection with the postulates of Euclid we find arising a new type of analytic procedure, namely the analysis of the logical foundations of a subject to see whether or not they can be improved. The long struggle to prove the parallel postulate from the other postulates finally led to the construction by Bolyai and Lobaschevsky of logically consistent geometries in which the parallel postulate of Euclid was replaced by an essentially different one. Thus we have the origin of the non-Euclidean geometries. Until quite recently the majority of scientists in other fields, if they knew anything about the non-Euclidean geometries at all, must have felt that they should be ranked among mathematical recreations rather than as a serious scientific study capable of application to the physical sciences. The general relativity of Einstein shows that this is far from being the case, and that without the theories which grew out of the logical qualms of the mathematicians it would not have been possible to replace Newton's theory of gravitation by a more general one. For this task there was needed not only the geometric ideas involved in the non-Euclidean geometries, but also the related analytical development known as the absolute calculus.

The importance of trigonometric series seems to have been first indicated in connection with the applications of mathematics to physics, and it was in connection with such applications that Fourier laid the basis for a comprehensive study of them. After Fourier, however, these series were studied by various eminent mathematicians from the point of view of their own mathematical content, aside from their utility in the

applications. It has been pointed out in an address[3] by E. B. Van Vleck how this study led to the development of many of the important new notions of nineteenth century mathematics, such as the Riemann integral, the point-set theory of Cantor, etc. In fact the whole present form of the theory of functions of a real variable has been largely conditioned by ideas which arose in connection with the detailed study of trigonometric series. This is one striking instance of many cases in which mathematics owes a debt to other sciences for suggesting problems which lead to noteworthy advances. I have insisted before that it would be a grave mistake for mathematicians to devote themselves exclusively to problems which arise in other sciences. It would also be a grave mistake to ignore such problems. For in addition to aiding in the development of the other sciences, the complete analysis of the problem from a mathematician's viewpoint often leads to important new ideas. However remote these ideas seem to be from the original problem, they frequently find application in the same or related sciences. It was by means of trigonometric series that Weierstrass and others succeeded in giving examples of continuous functions which nowhere possess a derivative. Fourier and his contemporaries, to say nothing of mathematical physicists of later generations, would have undoubtedly regarded such functions as excellent examples of the manner in which mathematicians sometimes waste their time. Yet an eminent physical chemist of the day, Jean Perrin, has pointed out that careful studies of the Brownian movement show that the trajectories of the particles suggest nothing so much as continuous functions without a derivative. In Chapter IV of his book "Les Atomes" we find the statement: "The entanglements of the trajectory are so numerous and so rapid that it is impossible to follow them and the trajectory noted is infinitely simpler and shorter than the real trajectory. Likewise, the mean apparent velocity of a particle during a given time varies wildly in magnitude and direction without tending to a limit when the time of the observer decreases, as we see in a simple fashion by noting the positions of a particle in the camera lucida, first from minute to minute, and then every five seconds, or better still by photographing them each twentieth of a second, as has been done by Victor Henri, Comandon and de Broglie, in order to cinematograph

[3] E. B. Van Vleck, "The influence of Fourier's series on the development of mathematics," *Science*, Vol. 39, pp. 113–124, 1914.

the movement. One can no longer fix a tangent, even in approximate fashion, at any point of the trajectory, and we have a case where it is truly natural to think of those continuous functions without derivatives, which the mathematicians have devised, and which one would regard erroneously as mere mathematical curiosities, since Nature suggests them as well as functions with a derivative."

In the preface to the same book Perrin takes occasion to justify at some length, and in admirable fashion, the more recondite labors of the mathematicians. Since the statements of a physical chemist can hardly be qualified as mathematical propaganda, I think it will be of interest to repeat some of his remarks.

"We all know how, before a rigorous definition is given, we point out to beginners that they already possess the notion of continuity. We trace before them a beautifully smooth curve, and we remark on placing a ruler against the contour: 'You see that at each point there exists a tangent?' Or again, to communicate the still more abstract idea of the true velocity of a moving body at a point of its trajectory, we say: 'You surely perceive, do you not, that the mean velocity between two neighboring points of this trajectory becomes approximately constant when the points approach each other indefinitely?' And many minds, indeed, remembering that for certain familiar movements it appears to be so, do not see that the situation involves great difficulties."

"The mathematicians, however, have well understood the defect in rigor of these so-called geometric considerations, and how childish it is, for example, to attempt to demonstrate, by tracing a curve, that every continuous function possesses a derivative. Functions with a derivative are the simplest and the easiest to deal with, but they are nevertheless an exceptional case; or, if we prefer geometric language, curves which have no tangents are the rule, and the very regular curves, such as the circle, are very interesting but very special cases."

"At first glance such restrictions seem to be only an intellectual exercise, ingenious without doubt, but definitely artificial and sterile, involving the pushing to a mania the desire for complete rigor. And, most frequently, those to whom one speaks of curves without tangents or functions without derivatives, begin by thinking that Nature does not present such complications nor even suggest the idea of them. The contrary

is nevertheless true, and the logic of the mathematicians has kept them nearer to reality than the supposedly more practical representations of the physicists."

It is well to note here that many of the leading workers of the day in other scientific fields where mathematics is applied realize quite clearly that mathematics has served them best by following its own lines of development. In a recent article by Langevin[4] we find the following statement: "It is nevertheless just and necessary to emphasize here the remarkable fact that among the abstract constructions realized by the mathematicians, while taking for an exclusive guide their need for logical perfection and increasing generality, none seems to remain useless to the physicist. By a singular harmony, the needs of the mind, desirous of constructing an adequate representation of reality, seem to have been foreseen and provided for by the logical analysis and the abstract aesthetics of the mathematician."

We also find in a recent paper by Dirac[5] the following remarks: "The steady progress of physics requires for its theoretical formulation a mathematics that gets continually more advanced. This is only natural and to be expected. What, however, was not expected by the scientific workers of the last century was the particular form that the line of advancement would take, namely, it was expected that the mathematics would get more and more and more complicated, but would rest on a permanent basis of axioms and definitions, while actually the modern physical developments have required a mathematics that continually shifts its foundations and gets more abstract. Non-Euclidean geometry and non-commutative algebra, which were at one time considered to be purely fictions of the mind and pastimes for logical thinkers, have now been found to be very necessary for the description of general facts of the physical world."

Finally, in a recent presidential address before the British Association for the Advancement of Science, we find the following statement by Jeans:[6] "Our knowledge of the external world must always consist of numbers, and our picture of the universe—the synthesis of our knowledge—must necessarily

[4] Paul Langevin, "L'orientation actuelle de la Physique." in *L'orientation actuelle des sciences*, Paris, 1930.

[5] P. A. M. Dirac, "Quantised singularities in the electromagnetic field," *Proc. R. Soc.* London, 133A: 60–72, 1931.

[6] J. H. Jeans: "The new world-picture of modern physics," *Nature*, Vol. 134, pp. 355–365, 1934.

be mathematical in form. All the concrete details of the picture, the ether and atoms and electrons, are mere clothing that we ourselves drape over our mathematical symbols—they do not belong to Nature, but to the parables by which we try to make Nature comprehensible. It was, I think, Kronecker who said that in arithmetic God made the integers and man made the rest; in the same spirit, we may add that in physics God made the mathematics and man made the rest."

After such eloquent testimony in behalf of my thesis from distinguished workers in other scientific fields, I can only make suitable acknowledgment by repeating my previous injunction to workers in pure mathematics that they should keep in touch with the developments in other sciences. It will always be eminently desirable that at least some of the mathematicians should be on the alert for new problems which arise from sources outside of mathematics. Such problems have provided a powerful stimulus of growth in the past and will undoubtedly continue to do so.

At the present stage of development of both mathematics and science, the relationships between them and their mutual services are best illustrated in the fields previously mentioned, namely astronomy, physics, and physical chemistry. There exists no branch of science, however, in which some mathematical procedure is not found essential. Moreover, the natural evolution of all scientific theory is in the direction of increasing use of quantitative methods. It is inevitable that the applications of mathematics in the more descriptive sciences should be enormously extended in the future. Many indications of the processes leading to such extension can be found in recent scientific advances in various fields.

For example the application of statistical methods in the biological and sociological fields is steadily increasing. In view of the fact that in the recent past no special mathematical preparation was regarded as important for workers in these fields, such an increase is noteworthy. We also find cropping up in these same sciences quite unexpected and rather startling instances of the possibilities of mathematical application. An example of this is found in the curve of healing of a wound developed by Carrel and du Noüy[7] during the late war.

Already in 1908, Dr. Alexis Carrel of the Rockefeller Insti-

[7] P. Lecomte du Noüy, "Recherches expérimentales et applications des méthodes de mesure et de calcul à un phénomène biologique: la cicatrisation," Paris thesis, 1917.

tute of Medical Research had noticed in the course of some experiments on animals that the rate of healing of a wound seemed to be approximately proportional to its surface area. Having devoted himself from the outbreak of the war to medical service in France he had occasion to notice a similar phenomenon in the case of wounded soldiers. He plotted a large number of curves, using the area of the wound as the ordinate and time as the abscissa, and came to the conclusion that the relationship could be represented by a mathematical equation. Not having time to work out the details himself, he turned the problem over to Dr. Lecomte du Noüy of Base Hospital 21, Compiègne, France. The latter found after some investigation that the curve of healing could be represented by means of an equation which served to express the area of the wound surface at any given time in terms of the area at the time of the first observation, the interval of time elapsed since the observation, and a certain quantity, i, known as the index of the wound.

It was further found by Dr. du Noüy that the theoretical curve deduced from the above equation agreed in general with the curve plotted from the observations, within the limits of the errors of measurement. When the observed area departed from the theoretical curve it was found to be due to some abnormality in the individual case, such as the presence of infection in the wound. In this way the presence of infection could frequently be determined by mathematical computations before it could be detected by direct medical examination. This is only one of the ways in which the curve can be of actual service to physicians in treating wounds. One of its further uses is mentioned by Drs. Tuffier and Desmarres in an article on the same subject. I quote their own statement which is as follows: "We believe that by mathematical measurements we can solve the problem of the action of various organic fluids on the cicatrization of wounds." Still another use of the formula has been indicated by Dr. du Noüy in one of his papers. The quantity, i, the index of the wound, varies with the age of the individual and the size of the wound. Hence, for a given age and wound surface there is a certain normal value for i, and any departure from this value in an individual case sheds light on the general condition of the patient.

This particular application of mathematics, in addition to its novelty and intrinsic interest, is of very great significance from our point of view. It sheds new and brilliant light on the

universality of mathematics as regards its usefulness in all fields of scientific investigation. For it gives us a first glimpse of an entirely new field of application for mathematics in a domain where the great majority of thinking men would have predicted there was no possibility of such application. In fact the great French philosopher, Comte, while recognizing that from a logical standpoint there was no reason why mathematics could not be applied to physiological phenomena, asserted that practically it was impossible to carry out such an application. In this connection it is of interest to quote from his monumental work "Positive Philosophy." In an early chapter we find the statement: "Nothing can appear less like a mathematical inquiry than the study of living bodies in a state of disease; yet, in studying the cure of disease, we are endeavoring to ascertain the quantities of the different agents which are to modify the organism in order to bring it to a natural state, admitting as mathematicians do for some of these quantities in certain cases values which are zero, negative, or even contradictory. It is not meant that such a method can be actually followed in the case of complicated phenomena, but the logical extension of the science, which is what we are now considering, comprehends such instances as this." A little later we find this statement: "Still further are we from being able to form such computations amidst the continual agitation of atoms which we call life and therefore from being able to carry mathematical analysis into the study of physiology. By the rapidity of their changes and their incessant numerical variations, vital phenomena are, practically, placed in opposition to mathematical processes."

In a recent article by Lapicque,[8] however, we have clear indication as to the manner in which the science of physiology is evolving into a form where mathematical applications will be not only possible but very essential. His remarks are as follows: "Formerly, not very far back in the history of humanity, let us say a century ago, almost everything was unknown concerning the physiology in the labyrinth of a living body. Magendie said: 'I wander around there like a ragpicker, and at each step I find something interesting to put in my basket.' This maxim horrified my teacher, Dastre, who was wont to say: 'When one doesn't know what he is looking for, he doesn't

[8] L. Lapicque, "L'orientation actuelle de la Physiologie," in *L'orientation actuelle des sciences*, Paris, 1930.

know what he finds.' For him the ideal of physiological research would have been to conceive in the quiet of one's study a theory explaining such and such phenomena, known but not understood (physiology is full of phenomena of this character), then to find, still by meditation, the experiment capable by a yes or no, of proving or disproving the theory. One would come then some morning to the laboratory, and that very evening the matter would be decided."

"These two tendencies, each in its amusingly exaggerated form, seem to me to serve the purpose of characterizing the temperament of naturalists and that of physicists. In proportion as physiology develops, the discoveries for ragpickers become more rare, and the possibility of working as Dastre dreamed is approaching. The progress of the physical sciences is one of the essential conditions of this development. Physical chemistry, notably the new fashion of interpreting the statics and dynamics of solutions, the role of membranes, the infinite variability of colloids, has opened for us new horizons and permits us to understand many phenomena which the older chemistry did not explain. Today, we tend more and more to explain the vital processes in terms of physical chemistry; we have before us an enormous domain to exploit in this manner."

Certainly if the physiologists are going to explain vital phenomena in terms of physical chemistry, they will need to make extensive use of mathematical methods. Colloids for example, which are mentioned above, are referred to by Perrin as one of the aspects of Nature which suggest continuous functions without a derivative. It seems quite reasonable to suppose that many of the future applications of mathematics in such fields as the biological and sociological sciences must wait on further development of mathematical theory as well as further development of the sciences in question. We should remember that the absolute calculus only reached definitive form some fifteen years before the publication of the first paper on general relativity. The present extensive development of the mathematical theory of atomic structure depends in part on advances in pure mathematics which are of quite recent origin. The inner details of biological phenomena are undoubtedly more complex than atomic structure, and the extensive application of mathematics to biology will in all probability involve mathematical theories as yet unborn.

On the other hand we have in existence beautiful and ex-

tensive theories of pure mathematics which have as yet found no application in other scientific fields. One outstanding example of this sort is the theory concerning the distribution of prime numbers among the other integers. Since all integers can be expressed as the products of primes, and since all the other numbers of mathematics rest on integers as a basis, there is ample justification for the statement of Landau that the prime numbers should be regarded as the "building stones" of mathematics. Recent developments in physical theory suggest that the assumption of a discrete structure for the material world, rather than a continuous structure, is more in accordance with physical reality. Perhaps prime number theory, like the conic sections of the Greeks, is waiting for some future Kepler to derive from it important theories concerning the physical universe.

The point that I would like to insist on in closing is the essential unity of all that can be designated as science. One outstanding purpose lies at the basis of all scientific endeavor, as the etymological origin of the word science indicates. We wish to increase our knowledge, both of ourselves and of the world about us. In carrying out this purpose each individual works best along lines dictated by his own tastes and inherent capacities. Some of us are for this reason mathematicians, and more particularly mathematicians working in certain special fields. If the theories we develop had no bearing at all on other scientific work, they would still have a value as exhibiting the capacities of the human mind. But the interrelation of the various scientific fields adds much to the solidarity of scientific interests. We should therefore rejoice that the relationships between mathematics and the other sciences are of such great service in the general development of scientific thought. It may not make our work any more interesting to ourselves, but it adds much to its broad human interest.

SUPER-NOVAE DISCOVERED IN 1937

The discovery of two great exploding stars, super-novae the astronomers call them, through use of a relatively small Schmidt telescope operating from Mt. Palomar, Calif., the future home of the great 200-inch reflector, was an outstanding feature of the astronomy of 1937.

These super-novae, only 15 of which had been discovered in all previous history, were each 500,000,000 times the sun's brilliance and they were both extremely distant in the heavens.

THE SEGREGATION OF CHEMISTRY STUDENTS AS TO THEIR NEEDS AND ABILITIES

By C. C. Warren

Hughes High School, Cincinnati, Ohio

To begin with may I say that there is little, if anything, new in the approach to this subject in my paper. It is possibly different from the method employed in your particular school system or chemistry department.

In this paper I shall endeavor to treat this subject from two approaches. First, a justification of segregating chemistry students according to their needs and abilities in our secondary schools and, second, the methods employed in our department at Hughes High School.

Educational opportunities have undergone certain marked changes during the past ten years. This, no doubt, has been due to the changing social and economic conditions. One of these changes has been the smaller number of our high school graduates who are entering college to continue their education.

In 1927 approximately 78% of the graduates of Hughes High School entered some institution of higher learning. It dropped to 51% in 1931 and this year we find only 34% of our graduates have enrolled for college work. And our high school is located in the University district.

This has resulted in a recognition, on the part of the teaching staff at Hughes High School, of three distinct groups of pupils that are passing through our doors each day. The first is the smaller groups who will go on to college. The second constitutes a group of students of marked ability whose formal education will end with their graduation from high school. The third, and possibly the largest group, consist of pupils who do not have either the ability or ambition to accomplish much. Some of this latter group will drop out before their junior year but many will stay on and secure their diplomas.

The chemistry department at Hughes High School recognized these divisions several years ago and modified its college preparatory course in chemistry to that of a general course in chemistry to meet the needs and abilities of this second group. This did not result in any depreciation of either the content or quality of the course. As a matter of fact it was the feeling that since this second group would not secure any further training

in chemistry after graduation they should receive in high school a broader, more complete and thorough course than had previously been offered. Recall this group represents those students of marked ability with a zeal and ambition to make the most out of their high school opportunities. Many of these will go to work in factories, hospitals and mills where they will have an opportunity to make use of their training in chemistry.

However, it is with the third groups that my paper largely deals. We must recognize that we have in a large high school today what we have in society at large, namely those individuals who cannot or at least will not do much.

They were not endowed by nature with either much ability or ambition. They seem to be very careful not to overexert themselves.

They are in our high schools and must be taken care of. They will not select general chemistry because it is common knowledge among the student body that it is one of the more difficult subjects. If they do not take chemistry they are forced into other subjects.

The present changing social and economic conditions have brought us this group of young people. What adjustments have we made in our curriculum to care for them? For the most part they have been very few. Many times we have forced the pupil to adapt himself to the school. We have taken the attitude that he can take it or leave it and much to our sorrow many have left it rather than stay and take it. The school must adapt itself to the pupil and help him adjust himself to our present plan of living. The need is for a course that will not teach our young people just facts and principles but will teach them about the world in which they live, and as one author has said, make of them "intelligent consumer's of technical services and goods." Herein lies the justification of a new type of course in chemistry.

We must recognize the need for a course in chemistry that not only meets the requirements of this group of our young people who will *not* go on to college but that will likewise be of value to a large section of our second and third year students who will drop out before their senior year. They have been carefully estimated to represent $\frac{1}{3}$ of the total number entering high school.

It seems to me that there is no subject that can offer so many points of interest, information and interpretation about

us as a practical course in chemistry. Many of the boys who come to us have their own home laboratories which absorb their leisure time and their pennies. They are crude no doubt and possibly sparsely equipped. These boys are eager for an opportunity to learn more about chemistry from books and even more eager for the opportunity to experiment in a well equipped laboratory. In such a laboratory we will find some working merely to satisfy their spirit of exploration and adventure. Others who may have special interest will be found developing their hobbies. Still others will be cultivating scientific attitudes that will provide them with a background in choosing a vocation.

Now as to the girls: Our present courses in general chemistry are not designed to meet the needs of the large group of girls who will not go on to college. These courses are uninteresting and of little practical value to the average girl of school age. There has been too much technical, scientific discussion with little or no actual application to a girl's everyday life. The majority of girls will enter wage-earning occupations for a few years after which homemaking will become their lifelong occupation. This relation between homemaking and chemistry is recognized by most high school teachers but there is still doubt as to the most effective way of teaching this relationship. A practical course in chemistry will challenge these girls to apply what they have learned to actual situations arising in homes, to find out for themselves reasons for happenings and encouraged to search out and find new problems.

The essential aims for a practical course in high school chemistry, are first that it should contribute to the understanding of the world and of human affairs, second, to seek to develop on the part of the student scientific methods by practice. Most psychologists agree that if improvement in ability to think is possible, it must be achieved through practice in problematic situations. Recent studies show that problem-solving ability comes, not by slavishly following directions, but by trying to do projects and problems. By such practice, the student is most likely to acquire those habits of thinking and acting, characterized as "scientific method" and "scientific attitudes." It should stress applications rather than mere theory and direct attention to the social implications of the subject.

It may or may not be a laboratory course. Personally, we, at Hughes, feel very strongly that such a course should include

actual laboratory work by the students. There is a value in learning how to manipulate apparatus without loss of time. Also there is a need, we feel, for students to learn how to carry an individual piece of work to completion without assistance. It trains them how to read and follow directions carefully. Any understanding of chemical principles depends upon acquaintance with facts and facts are best learned by direct observation. No doubt a practical course in chemistry could be given with the experimentation being limited to demonstration work by the teacher. Our feeling here, has been, that our individual laboratory work in practical chemistry has certain benefits which cannot be overlooked, and so we have made the laboratory work a part of the course.

Now, as to the second phase of this subject, namely the methods employed in our department to segregate the students according to their needs and abilities.

As a result of the reorganization of the secondary curriculum in Cincinnati several years ago one year of an elective science was set up as a requirement for graduation. During the ninth year either botany, zoology or general science could be elected. Students were, no doubt, encouraged to select general science in preference to botany or zoology. During the tenth year botany, zoology or general science, were again the electives. No students could elect general science in the tenth grade to fill in a major or minor if he had had any science in the ninth grade. During the eleventh and twelfth years physics and chemistry were established as electives.

At that time we were offering a standard course in general chemistry and a separate course in household chemistry for girls only. Within a short time it became apparent to the administration that this course in household chemistry would have to be reorganized to meet the needs of many juniors and seniors, boys as well as girls, who had thus far failed to either elect their one year of science necessary for graduation, or who needed an additional year of science to fill out their minor.

It was apparent that this group of boys and girls were not interested in science as a major and in all likelihood would not continue their scholastic work beyond high school graduation. So a course in practical chemistry was established and opened to all junior and senior boys and girls without any prerequisites. Any student in either his third or fourth year may now elect practical chemistry. Students who have reached their third or

fourth year and have not thus elected their one year of science necessary for graduation are required to take either practical chemistry or practical physics. Our requirements for general chemistry differ in the respect that a student must have had grades above 80% in all his work and at least one year of mathematics.

This new course in practical chemistry was, in reality, a modification of the old course in household chemistry. This modification has continued for several years and is certainly not complete as yet. I doubt if it ever should be a fixed type of course. To my way of thinking it should be kept sufficiently elastic in order that it can be altered from time to time to meet the needs of our students as those needs may change due to the influence of changing economic and social conditions.

Our modification started out in two directions. First the initiation of the writing of a series of experiments that we felt would meet the needs of the group of students taking practical chemistry. Second, the adoption of a practical chemistry text to supplant the text in use in household and general chemistry.

These experiments have been developed and written the past few years by the men in the chemistry department at Hughes. They are fifty in number and their content is as follows:

Introduction experiment on structure and care of apparatus
Cutting and bending glass tubing
Physical and chemical changes
Mixtures and compounds
Oxygen, preparation and properties
Heating a metal in air
Hydrogen, preparation and properties
Electrolysis of water
Solutions, suspensions and emulsions
Distillation of water
Temperature and solubility
Water of crystallization
Hydrogen peroxide
Preparation and properties of bases
Acids, bases, neutralization and salts
Types of reactions
Methods of preparing salts
Sulfur
Hydrogen sulfide and hydrosulfuric acid
Sulfur dioxide and sulfurous acid
Properties of sulfuric acid
The composition of air
Ammonia and ammonium hydroxide
Preparation and properties of nitric acid
Carbon
Destructive distillation of coal and wood

Preparation and properties of carbon dioxide
Preparation and softening of temporary hard water
Preparation and softening of permanent hard water
Leavening agents
Tests for acids and starch
Analysis of baking powders
Fats and oils
Scouring soaps and powders
Testing soaps
A further study of cleansing agents
Sugars
Starches
Hydrolysis of starch
Proteins
Milk
Butter and butter substitutes
Tests for animal and vegetable fibers
Action of hydrochloric acid upon different fibers.

At the present time we are working on several additional experiments, namely:

Fermentation of molasses
Bleaching cotton goods
The conditions necessary for dyeing.

As to the textbook may I say that we abandoned the household chemistry text three years ago. Since then we have been using a general type chemistry text and omitting the more difficult sections that we felt would not be of value to the type of students we were receiving.

This fall we adopted a textbook that was edited this year for the first time—a book that we feel is certainly more practical in its nature.

The best features of the book are the discussions of method which appear quite often throughout the book. The book is short, approximately 450 pages which to my way of thinking is something we have needed for quite a while. The general chemistry texts have seemingly become larger with each edition until some of them approximate nearly 700 pages. I have never found it possible to cover such a text, and do it adequately, in the course of any single school year.

The book has a number of weaknesses, as possibly all chemistry texts have. Certain weaknesses in content we are correcting, to some extent, by adding and supplementing material of our own.

We are not entirely satisfied with the book, but we feel that it is a step in the right direction.

Several chemistry texts came out this year of this nature under various titles. They all recognize that we are receiving in our secondary schools many students who desire and who need a course in chemistry but whose abilities will not permit them to take a course in general preparatory chemistry.

There is, no doubt, need for improvement in some of the books just out. There is also a need for additional textbooks of this nature.

We as chemistry teachers, I feel, must recognize the needs and abilities of this large group of pupils coming to us and not be too slow to formulate a course to meet their needs.

NEW USES FOR THE DECIMAL POINT

By Joseph A. Nyberg
Hyde Park High School, Chicago

If you still read the financial pages of a daily paper you will notice that certain U. S. Treasury Notes are quoted as 106.25, for example. This does not mean, as you once learned, that the note sold for \$106 and 25 cents, but for \$106 and 25 thirty-seconds of a dollar. Likewise you will notice that the 6% preferred stock of the Public Service Company of Northern Illinois is quoted as opening at \$120½ and selling as low as \$120.15. The first quotation means \$120 and 50 cents; the second means \$120 and 15 thirty-seconds of a dollar.

This use of the decimal point to denote thirty-seconds began a few years ago in quoting prices on Liberty Bonds. Previously an eighth of a dollar had been the smallest variation in stocks and bonds. Newspapers evidently found it inconvenient to set thirty-seconds in type and began using the decimal point. It has even been used to denote sixteenths. For the benefit of future historians some one should locate the exact time when the practice began.

Psychologists have also found a new use for the decimal point. Rather than write 12 yr. 5 mo. as a pupil's age (chronological, mental, or achievement in some activity) we now frequently see this written as 12.5. The decimal point thus represents twelfths instead of tenths.

So far the new uses have not found their way into textbooks on arithmetic, but sooner or later the schools will need to teach what the rest of the world is using.

BLACK GOLD

A \$3,330,000 company has been formed in Australia to produce oil from shale at Newnes (New South Wales). The Commonwealth Government is backing the scheme to the extent of more than \$1,000,000 and the State Government of New South Wales is subscribing over \$800,000. The remainder is subscribed privately. It is hoped to produce 10,000,000 gallons of oil a year but this will only represent 4% of Australian consumption.

The initiation of this scheme is regarded as a valuable defense measure as Australia so far has been entirely dependent upon other countries for her oil.

ANT STUDY IN THE BIOLOGY CLASSROOM

By A. S. Windsor
General Biological Supply House, Inc.,
Chicago, Ill.

Modern biology is a dynamic science. Life processes must be observed and correlated with the knowledge of structures gained from dissections, otherwise the teacher does not consider his task as complete. You, the biology teacher of today, spend much less time over dissecting trays and therefore can devote a greater share of attention to field work and the study of living plants and animals in your laboratories than was the case with your predecessors. In this way alone, can your students find out about their own status in this environment of living beings; can they properly orient themselves in a pulsating world of creatures, all to some small extent, at least, dependent upon each other. A decade or two ago and we *read* a smattering of biology out of a textbook, while the real world laboratory lay unexplored! But not so today! Many biology teachers are so successful in this newer, *this living biology*, that they have made it possible for their students to observe in the classroom some living examples of practically every phylum in the animal kingdom.

Insects, which far outnumber all other terrestrial animals, are naturally most easily available for study. It is not surprising to find a whole host of representatives of this class which are studied quite commonly in your laboratories. Almost anyone can obtain living moths, mosquitoes, blow-flies, praying mantids, walking sticks, cockroaches, grasshoppers, beetles and the like, at some season during the year, so that a thorough study of their life histories and habits is possible. I should like to recommend that we make *more commonplace* the intriguing study of ant life. Ants represent the highest type of social insect life and are to be found abundantly in almost any given locality—what is more important, at almost any time of the year. Please do not be surprised when I tell you that you can keep colonies going throughout the entire year if you wish. Or, you may wish to "put one over" Sir John Lubbock who kept one colony under observation for more than seven years! It seems rather peculiar in one way, and yet nonetheless true, I believe, that a high percentage of people seem to have an innate fascination for these denizens of the dirt and their activi-

ties. Did you ever stand over a group of the small brown lawn ants, busy excavating their underground runways, and not feel a certain admiration for them, even though you knew that their industry was to the immediate detriment of your lawn? Unconsciously, you were beginning your ant study.

I seem to sense that there are two fundamental questions you are about to ask me—call it mental telepathy or the natural result of having talked to teachers individually about the matter. First, "How may I introduce this study to my students?" and secondly, "What observations are we likely to make which would so captivate student interest as to insure the complete success of the study?"

There are two ways for initiating the study of ants and I shall have to let you decide whether one means is to take precedence over the other. In my several years of experience in my hobby, I shall have to say that I do not regard either as complete within itself, that each must be supplemented by the other. Field study is the logical beginning point. On one of your field trips while the weather is still warm, locate a fairly large ant mound—but do not disturb it or the orderly processes of the inhabitants. Sit down beside it. Take notes—have groups of four or five members of the class rotate at the pleasant task of recording every observation made. Prompt them with such questions as: "Are all the workers of the same size?" "Do you find these ants on any of the weeds or low shrubs in the immediate vicinity?" and "Why are they there?" You see how just a little thought will provoke an endless barrage of questions, but mind you, it is your duty to offer these prompting questions and that of the student to try to make sufficient observations to enable him to answer each satisfactorily. And thus you will find that a new world of interest is opened up for the entire class.

These observations, stimulating though they can be, leave something to be desired. The students can appreciate all they have seen, but try to keep them from searching deeper to find what goes on within the portals of this earthen empire! They want to know what mysteries are hidden from their view. Being mindful of your conservation ideals, allow one student to dig into the mound with trowel. Doubtless you will find many of the developmental stages, as well as the winged male and female castes which could not be seen unless this action were taken. Place this general mixture of ants, their brood and earth

into a jar for removal to the laboratory—and carefully return the earth of the mound to as nearly the former condition as possible. Never leave an unsightly wound in the mound.

This brings us then to the second means for initiating the study, that of laboratory observations. One may wish to proceed in the simplest possible manner at first, and, if so, leave the ants in the jar of earth; but substitute a cloth for the lid. It will not take long for them to set up suitable living quarters in this modest home. Construction of runways, care of brood, reactions to light and many other interesting nest habits can be observed without the expenditure of one cent. When you have done about as much as possible with this arrangement, then I would suggest that you remove the ants and brood only to a flat type, earthless nest, which is by far the best for controlled study. For a quick transfer when the temperature falls below 32°F., one may work outside of the building so that the ants will become sluggish and, when massed together at the bottom of the jar, may be transferred to the cold nest by forceps. Or better, on a laboratory table, set up a barricade—make a corral to use a cowboy term—of plaster of Paris, heavy grease, or arrange a water moat. Place the flat nest inside this and, near to it, empty out the contents of the jar. Eventually, the ants will leave the dirt as it becomes drier and take up their residence in the more humid nest, where there is food. While this latter procedure takes longer, it is the more satisfactory method.

There are many different types of observation nests available. Each has its good points. If you find it more advantageous, construct your own ant home. Wood is a desirable material for most species. Cement, while frequently used, seems less desirable than wood. Plaster of Paris is quite satisfactory as a "storage case" and in combination with a wooden chamber is an excellent means for keeping the laboratory colony. The display cases on the table before you illustrate some possible types.

At any rate, we have now started upon our serious study of ants and we should now refer back to our second question you asked me about the interesting observations which await us in this study. For the sake of convenience, will you consider yourselves as having come upon an imaginary visit to my "ant round table"? By so doing we shall have our choice of about twenty different colonies and I am sure that this will allow us within a relatively short time to make a wide range of

observations which might easily require several weeks were we to have but one single group under observation. Mind you, these are all common Northern species and doubtless most of them occur in your own locality.

Perhaps the most striking ants in this miniature zoo are the large black Carpenter ants (*Componotus pennsylvanicus*), all too well known to most farm boys who have had any wood-chopping experiences. The true story as to the origin if this particular colony is interesting as I reflect back upon it. My 8-year old son discovered it. I had looked for several weeks when out in my usual collecting haunts far from the city, trying to locate a colony to add to my group but all of my efforts were in vain. While playing, the boys decided that they wanted to build a small fire in a vacant lot and as fuel, took an old cedar post which had been stored under the front porch of our home. They were surprised, upon splitting it, to find a central cavity packed with a black mass (this was during cold weather), which turned out to be these same ants which we are observing mentally. They saved them and I was agreeably surprised to learn of the "catch" when I returned home in the evening. This is truly typical of ant-hunting; you never know just what you may find, but usually—I might say, almost invariably—there is some thrill in store for you for each day which you spend in the field. It is seldom that I return without something which I wanted even though it might have been a far cry from the creature which I had hoped to find when starting on the trip.

The Carpenter ants were under observation for about two weeks when the queen laid a small cluster of yellow eggs each nearly 2 mm. in length. These were a nice addition to the rather large assortment of larvae which were taken with the adults and which we now see segregated to themselves in one corner of the nest. The latter are white—just the color which you usually associate with grubs. Note that they vary greatly in size; some are older than others and the different castes also cause a size variation. The adult workers are almost always near them, licking them and feeding some of them at most times. You ask about those buff colored objects about 7 mm. long which we see in the other corner. They are commonly called "ant eggs" by those who do not distinguish between the different stages; in reality, are cocoons enclosing pupae. Some are darker than others and we learn that this is due to age,

those having spun their cocoons only recently are light in color while those about ready to emerge are decidedly darker in appearance. The latter have already assumed a certain amount of their pigmentation and it is this which shows through the pupal case. However, their full dark hue is not to be seen until quite some time after they have emerged.

You will be interested to know that in this colony we were able to watch a larva spin its cocoon. If you want entertainment, observations such as these will furnish it—not to speak of the scientific angle of it. Competing closely with this process in the matter of attention-getting was the emergence of a callow from a cocoon. Three adult workers seemed definitely responsible for seeing that this young lady made her entrance into adult life in the proper manner. All of the other workers were quite indifferent to the occasion, never came near the half opened cocoon. If one were ever tempted to use a human emotion in describing ant behavior, he would have while watching the efforts of the three ants trying to extricate the feeble callow out of her "wrapper." The whole process lasted for close to an hour. Real cooperation between the workers was necessary to remove the envelope, two pulling at the callow and the other tugging at the cocoon.

For the ants in the next nest, we should use our binocular microscope for they are quite small and we shall be unable to see much of their activities unless they are magnified. Peering down through the tubes we see a cluster of shiny bodies interlocked and intertwined about a central larger ant. Strong light is thrown on the mass and enough of the small workers crawl away to expose the wingless queen. They do not leave her entirely, seem to be so very careful lest she be subjected to some adverse condition that they prefer to linger in a closely packed group. These are *Leptothorax longispinosus*. They are rather hard to find because they are so small that a thriving colony may live in a tiny crevice, no larger than a pea, in an old goldenrod root.

May I tell you about the first *Leptothorax* which I collected? I had been out on a little field trip with my son and we had been collecting a few of the large garden spiders which were unusually abundant at the time. We had been looking at an enormous female entangle a grasshopper in her web when she suddenly dropped to the ground. We were anxious to see her feigning act and bent down under the weeds to find her. There

she lay, no sign of movement, just as though she were dead. But, I happened to catch a glimpse of some fine "sawdust" near the root of a goldenrod. Somehow I questioned it and decided to try to find out what had caused it. Could it be the work of ants? The goldenrod plant, still in flower was uprooted and this gave me the chance to see a small opening into the basal portion of the stem about an inch above the surface of the black dirt. I cut into the stem and then split it lengthwise. There they were, dozens of the little reddish ants, slightly over 2 mm. in length. Thus another ambition was realized.

One of the commonest ants in Chicagoland is *Formica cinerea*, and we should not pass them by in our nest observations. The thriving colony which we have upon our imaginary table was removed from a large mound about a foot in diameter and which stood about ten inches above the general level of the surrounding ground. You see that there are several queens in it, which leads me to say that I at one time removed exactly 49 queens from a similar mound. And, there were others left for I did not completely obliterate the community. These ants are quite timid and are frequently attacked during the warm days of July and August by the slavemakers, *Formica Sanguinea*. The *cinerea* brood is taken, larva by larva, pupa by pupa, back to the nest of the raiders. This gives rise to a mixed colony such as we could demonstrate without much trouble. These ants have other insects take advantage of them too. You may see the small Histerid beetle in this nest, a true myrmecophile, which was taken along with the ants. They do not seem to object to its presence; on the contrary they may be seen to regurgitate food to it. Food which should go to the brood by all that is right and proper. One could watch this comical relationship hour after hour. The beetle always gets regal treatment and one does not wonder that it is so content-looking when in a large group of ants.

This particular colony of *cinerea* has been trained to move from one compartment of the large wooden nest to the other when the chamber in which you desire them to be is darkened. This does not require a real "training period" for you will notice that a new colony will remove to a dark place rather quickly. By repeating the process a few times they seem to know just what is expected and make the shift much more rapidly. This has very definite advantages since it allows one to clean the compartment vacated and make other adjust-

ments which are necessary to the maintenance of the colony. Not only do the ants move from chamber to chamber in response to the darkening, but they also take along some of their treasured possessions so that they may enjoy them in peace. For example, a large mealworm was cut into two pieces and placed in the light chamber. Several workers clustered about them and slowly tugged away until they had dragged them the entire length of the nest into the dark compartment. In this same connection, there are usually a few rather recalcitrant ants which do not seem to feel the urge to move into the darkened chamber as promptly as the majority. These are picked up bodily in the mandibles of some energetic workers and transported to the secluded chamber. When this activity begins while you are watching the ants you hope that it will keep on and on for it is thoroughly entertaining.

To glance at some of the other nests momentarily would be to see such interesting forms as *Prenolepis*, with the greatly distended gasters, slowly waddling about with their onerous burden of sweet juices. And there we should see *Lasius americanus* the small brown lawn ant, the commonest insect in the world! What a large queen in comparison to the worker caste. The true ant pygmies could be seen in numbers, so small that they can turn about on the head of a pin. There would be different stages in each, there would be a different sort of behavior in each, and the mysteries of ant-life would soon be disclosed to us if we had time for thorough observations upon them. But this is without the purpose of our little talk. We wanted to let you know just a few of the experiences which are in store for you if you have never devoted any attention to the study of ants in your laboratories.

For those who are anxious to have the opportunity of performing a number of serious experiments on ants, I should suggest that you refer to the book *Ants, Bees, and Wasps* by Lubbock (Dutton). The classical American work is *Ants* by Wheeler (Columbia University Press). The lives of the great myrmecologists would be splendid outside reading for your students.

CORNELL RURAL SCHOOL LEAFLET

Have you seen the November 1937 issue of the *Cornell Rural School Leaflet?* Its title is, "Are They Vermin?" It is about hawks, owls, weasels, skunks, foxes, and other interesting members of the animal kingdom.

AN OUTDOORS SCHOOL FOR THE ELEMENTARY SCIENCE TEACHER

By Robert B. Gordon, *Director*
The Allegany School of Natural History, Quaker Bridge, N. Y.

Most of you will agree with me that the facts of elementary science are best presented in an informal manner. Even if we have learned our science by means of well-organized lectures, laboratory demonstrations and textbooks, that is no reason *per se* for following the same formal plan in teaching science to youngsters. Some of the best naturalists I know got their start because of their love of things outdoors. I should like to tell you of a young lad by the name of David, scarcely past his sixteenth birthday. I met him last summer, and viewed with interest his colorful collection of butterflies including Californian species which Easterners seldom see. "Another collector," I thought, but I said little about it, complimenting the lad on his marvelous personal collection. As you all know, a great many people collect butterflies and birds' eggs and sea shells for the same reasons many people collect postage stamps. I had instinctively rated David as just another amateur collector. As the summer passed, I learned that David had raised from the larvae many of the specimens in his collection. He had sufficient first hand experience to tell whether a given caterpillar would develop into Cabbage Butterfly or a Cecropia, what the caterpillar's food plants were, about when a given caterpillar would be ready to pupate and when the butterfly would be expected to emerge from its chrysalis. All of these facts and many more about butterflies David had learned not in school nor in his Boy Scout troop, but from patient, persistent observations of his own. The collection was merely some visible evidence of accomplishment, a natural history record with much enviable knowledge back of it. Are not your chief objectives, as elementary science teachers, to develop incentives for young people to make independent observations and to interpret correctly what they see?

The outdoors school has certain values and special features which I should like to emphasize. First, it is a place to learn informal methods of presenting the facts of elementary science because nature is the background and field instruction replaces formal lectures and laboratory. Second, it is a place to acquire more thorough, first hand knowledge of subject matter. Third,

it is a place for healthful recreation and inspiration, because of contacts with other scenes, other teachers, other methods, and other points of view.

Enlarging on each of the above points in more detail, first, I believe that the biological research station and summer school devoted to the natural sciences are excellent places for teachers to observe informal methods of teaching. The majority of college courses in science have been characterized by too much formality. We have seen a great many changes in this respect during the last quarter century. The increased number of laboratory hours, field trips, inspection tours, clinics—all are evidence of this practical trend. In the outdoors school, teachers and pupils live together, often eating at a common table, working together in the same laboratories, and sharing the same experiences on field excursions. The touch of nature makes them kindred souls in learning.

Second, I believe that the biological research station and summer schools devoted to the natural sciences are excellent places for science teachers to acquire a first hand knowledge of subject matter. In spite of our earnest endeavor to study nature, not books, we are continually falling back for authority on the word of some one else, from famous lecturers, from writers of textbooks, and from science articles of all sorts. Science, like every other branch of knowledge, is full of seeming contradictions. One authority says this; another equally good authority says that. Whom are we going to believe? What are we going to teach? The answer to the dilemma is to rely more and more upon our own powers of observation, to form our own conclusions, and to suspend judgment in matters controversial, until we get more direct evidence to make a fair decision. In the outdoors school teachers and students make the same observations, repeat them again and again and, if they find no striking exceptions, are well on the way to establish some important general principles which have real educational value.

Third, I believe that the biological research station and summer schools devoted to natural sciences are excellent places for teachers to acquire inspiration, new ideas and physical improvement in a different environment. After nine months of teaching day after day in the same schoolroom in the same building, in the same neighborhood, a change is good for the soul. Some teachers are so fatigued from the months of teaching that they

take the whole summer just to rest up. When school begins, they are right back where they started, and perhaps glad their contracts were renewed. Have they been inspired during the long vacation period? Have they enjoyed feasts of the mind? Have they improved themselves physically? Are they better prepared to do a better job of teaching than they did last year? Unfortunately the answer is all too often "No"! In outdoor schools the healthful outdoor activities, intimate association with nature, and companionship with others who have a common bond of interest, awaken the spirit of nature's noblemen, shared by Thoreau, Gibson, and Burroughs. Fortunately there are a large number of summer schools of natural history and biological stations, from Maine to California and from Washington to Florida, some in the mountains and some in the plains, some on inland lakes and some on the seacoast. If you wanted to choose a different station every summer, you could do that for the rest of your life, without going to the same place twice. The various kinds of summer schools devoted to natural science may be roughly classified into three main types, which I shall designate as 1) The Biological Research Station; 2) the Nature Study Camp; and 3) the School of Natural History.

In the first group one immediately thinks of the Marine Biological Laboratory at Woods Hole, Mass., the University of Michigan Biological Station at Douglas Lake, and Oceanographic Laboratories of the University of Washington at Friday Harbor. There are several others in this group. They boast of unusually well-trained staff and the finest of equipment. For the most part they cater to graduate students and specialists engaged in research. Courses of an advanced character are offered, frequently in the nature of seminars.

In the second group we have the Nature Study Camps. To a teacher who cannot afford time or money to take more than a short course of one or two weeks under enthusiastic leaders, the nature study camp fills the need exactly. If you are interested in birds and life along the seacoast, I should unhesitatingly recommend the Audubon Nature Camp in Maine. Others in the East include the American School of Wildlife Protection, the New Hampshire Nature Camp, the Pennsylvania State College Nature Camp and Dr. William Vinal's Nature Guide School. I run the risk of criticism at this point but it is my candid opinion the Nature Study Camp is designed to impart inspiration and nature lore in allopathic doses for an all-too-brief

period. Although you will learn some very interesting ways of presenting the facts of nature study, you cannot learn much about nature in two weeks. If you try, you belong to the same class as the ambitious person who attempts to see New York in one day. The Nature Study Camp is a great place to observe methods and you could profitably attend two or three such camps in a single summer. This would be advantageous to any elementary science teacher.

A third type of outdoors school for elementary teachers is the School of Natural History. A growing number of colleges and universities are offering field courses of college grade, where the residence requirements may vary from four to seven weeks, the average being about six weeks. For the most part they are limited in enrollment. Classes are limited to eight or ten, twelve or fifteen, the maximum number which can successfully be accommodated on field trips. The smaller classes offer distinct advantages to the students. The courses given include field botany, field zoology, geological field work, field ornithology, entomology, plant and animal ecology. From a recent directory of summer camps and biological field stations published by the General Biological Supply House (1937) between 20 and 30 institutions offer courses of this sort, for which college credit can be obtained. Some of the "outdoors" summer schools offer "indoors" courses such as cytology, genetics, microtechnique, lution and physiology. In my opinion these could just as well be taught and with better equipment, perhaps, within the four walls of a classroom or college laboratory. The chief advantages of taking such work at a biological field station are to get courses from professors whose love for biological research brings them every summer to the same station, and to enjoy the camp life and recreational opportunities afforded by the school's location. I suppose these are reasons enough.

All of these outdoors schools have several special features in common. I shall merely list them, with brief comment, before proceeding to the lantern slides which will illustrate what one outdoors school is like.

1. Nature is the background instead of four walls. To be sure buildings are necessary to house the students and staff, to furnish laboratory space where microscopes can safely be used, and to furnish a library of reference books, rather than textbooks. First-hand experience with nature is better any day than mere book-knowledge. The authors often make mistakes and

their statements are often unscientific. One can find innumerable examples from Plato to Archibald Rutledge. I am afraid that too much instruction centers around the polemics of adaptation or fitness to environment. Some of the statements found in older textbooks of biology and nature study handbooks are full of purposeful teleology and will not bear critical inspection today. An up-to-date field course should bring both instructor and student to a more scientific point of view in interpreting natural phenomena. One teacher with normal school training and nine years of experience was amazed when I contradicted a fellow student who answered a question by quoting from his textbook. It was the first time they had been brought to realize that the writer of a textbook might occasionally be wrong.

2. Informal field instruction takes the place of formal lectures and laboratory exercises. Students learn about plants and animals and rock formations as they find them. A well-informed biology teacher from New York City on her first botany field trip was delighted to see a green leafy liverwort growing in the woods. She had taken a semester's course in morphology of the bryophytes, but had never seen a living specimen until she attended this outdoors school. The real thing in its natural setting is at once more interesting and instructive than the best preserved specimens and colored pictures.

3. Probably one of the finest contributions an outdoors school can make is the intimate daily contacts with other teachers, other methods, and other points of view. These are essential to making improvements in what we teach and how we teach it.

WILL BUILD STATION IN CALIFORNIA FOR ORIENT-U. S. RADIO

Regular direct short-wave radio broadcasts between the Orient and the United States are expected to be made possible with the construction of an international short-wave radio station at Belmont, Calif., by General Electric.

Scheduled for operation on two frequencies, 9.530 and 15.330 kilocycles, already assigned to two General Electric stations here, the new station will enable beam transmission to the Orient without making the radio waves pass over the magnetic pole, Chester H. Lang, broadcast manager revealed.

The transmitter will be the first such built west of the Mississippi River, it is claimed. Stations east of the big river have been unable, Mr. Lang asserts, to carry on regular broadcasts between the Far East and this country because the direct beam, in going by the shortest "great circle" route, passes over the magnetic north pole, with consequent interruption of the radio waves.

A DEFENSE FOR SURVEY COURSES IN THE JUNIOR COLLEGE

By Joseph M. Synnerdahl
Saint Xavier College, Chicago, Ill.

You doubtless are familiar with the recent trend toward general education in the junior college. And I trust you have some conversance with survey courses, which aim to serve as the working medium for the fulfillment of the general education plan.

Survey courses suggest new problems, and thereby create a yearning for the past when all problems were so nicely settled, at least in retrospect. However, it is a social principle, as well as an educational principle that once we have passed socially through any stage of development we never again return to live that stage. We always move into a stage further on.

This modern educational movement toward planning general education suggests the existence of two things—

1. There must be dissatisfaction of some kind with the present type of organized machinery.
2. There must be evolving an educational idea that is appealing to the minds of educators in this section of education.

The survey course movement is partly a direct attack on what might be called specialism, or departmentalism, or classifying knowledge into categories arbitrary and unchangeable, and endowing them with a significance such as no classification should ever have. As a consequence the specialist has a very high regard for research and knowledge in his own field, a lessened regard for the research and knowledge of a closely allied field, and an utter disregard for those working in other fields.

Let us see what these dissatisfactions are. I believe there are six or seven. However, I shall mention just one or two. One of them is the dissatisfaction with the product that we turn out from our colleges through the present form of specialized or departmentalized training. We are truly educating youth with partial minds whose attitudes are undisciplined and extemporaneous. We would, on the contrary, like to find that our educated product is tolerant, cosmopolitan in spirit, and catholic in interests and attitudes.

Another dissatisfaction springs from the way in which ele-

mentary courses in general education are derived. In the past they have been derived exclusively from special fields. In developing an elementary course, say in Physics, the specialities, such as mechanics, sound, and light, etc. are analyzed, and some principles are taken out of each—the compilation of these has been erroneously regarded as a survey course. When a student completes such a course, he is well fitted to go on in the specialist field. But the student who does not continue in this field profits little, for he has studied principles not in terms of general life situations, but rather in terms of a special field that lies ahead, and in which he will take no part.

What ideas lie back of the survey course movement? I believe two ideas are uppermost in the minds of those who are struggling to obtain a better, more comprehensive social functional form of education. One might be called the principle of integration. The other is based on the notion that we might do more effective teaching if we would but utilize the larger units of our social and physical environment in seeking these understandings. Most survey courses in the social sciences, for example, utilize the Industrial Revolution as the integrating principle about which all current social developments that affect the lives of individuals in this age so profoundly are unfolding. The net effect of this "synchronized" training is to enable the student to separate the individual from his faults and his shortcomings, which may be incident to his own personal life or to the age in which he lives, so as to make him (the student) forebearing in his criticism of and sympathetic in his attitude toward mankind. We habitually associate misfortune with failure, and treat the recalcitrant with scorn because of an inadequate social perspective. However, those who are socially minded do not behave so narrowly for it becomes their broader purpose to uplift fallen humanity. In the natural sciences, an attempt has been made to cut across many fields, to bring the student in contact with great scientists, both living and dead, and to give young people a better understanding of the principle of evolution which reflects the greatness of the Creator. The place of an orientation course in the Biological Sciences for American youth is therefore preeminent. And its contributions to general culture need no proof. To the trained eye the roadside is a wild garden which the observer loves as he could love no cultivated garden, no matter how well kept. To the untrained ear, the woods and parks ring with confused murmur. But to

the trained ear that murmur is a harmony of many clearly marked tones. In the Physical Sciences, the rhythm of the material universe is sounded, and harmony is brought out of chaos by recourse to the basic principle of primordial development. So, unwittingly the natural scientist has found the need for an integrating principle, and therefore has gone back to the large principle of evolution.

Now as to our seeking after larger and more comprehensive units in our social and physical environment. The specialist organizes and presents his material in terms of the specialities of his field. In a course in physics, chemistry, or shop mathematics, designed for Pre-Engineering students or the like, his specific objectives are probably justified. For if the student fails to integrate the elementary principles in this course, he is going to live through these principles again in subsequent courses, and as he comes in contact with them, over and over again, he will ultimately synthesize them. But for others, such an opportunity of recurring example upon which proper induction is necessarily based is not available; hence the student in general must be given an understanding of the great principles involved in the various specialties. By means of a broad and comprehensive orientation of subject-matter as presented in a survey course, the student is prepared to see how the elements of life operate around him so that he may gain appreciation of the great physical principle of life.

The case for the survey course is predicated upon these two theses:

1. Just how valid are these lines of attack that are being made upon deriving a general education from the specialist approach.
2. How successful may we be in our search for these integrating principles about which we can build a significant educational offering, if we consider subject-matter not per se, but rather with reference to these very great and significant outcomes.

I leave the final answer with you.

MAN GROWS OLDER IN 1937

Homo sapiens has something new to be proud of, since anthropologists in 1937 dug up evidence that our own species of mankind was on earth much earlier than supposed. Skeletons in Palestine caves reveal Homo sapiens present among other, less enduring types of Old Stone Age man as early as 60,000 years ago.

A UNIFIED SCIENCE COURSE FOR THE INTERMEDIATE GRADES

MARTHA JUNE JONES
The Deming School, Terre Haute, Indiana

The science program in the intermediate grades is yet in the stage of orientation. In some school systems it is not a part of the regular program and is taught incidentally, if not entirely omitted.

It seems unnecessary that there is need for justifying science in the fourth, fifth, and sixth grades. All who study and observe the nature and interests of children in these grades have many daily evidences of their interest in the objects and phenomena in the world about them which is teeming with science. Shall we push such interest aside or shall we stimulate this natural curiosity by: encouraging questions, raising problems, guiding and directing the child in finding their solution.

What has interfered with the successful teaching of science in these grades? For a time there was a widespread philosophy that science and nature study should be placed on an incidental basis. If a child brought a flower to school, there was to be a lesson about flowers. If a snake were brought in it was expected, by those holding this philosophy, that there would be a lesson on snakes. Such teaching has its place, but it is not enough.

To observe and to be able to identify objects became the objective of the natural science work. Unless a teacher had exceptional training in science such a condition would lead only to discouragement and despair. Science teaching became incidental, accidental, and in many places completely ignored.

What has been the most direct cause of such a condition? Many teachers lacked the training in science which would give them a sufficient subject matter background for teaching science. The science courses they had taken in high school and college were too technical or too much of the pure science to be able to see the application to lower grade levels. However, some teachers' colleges now are requiring a full year of simplified general science which gives the teacher a better background in the several phases of science included in a broad elementary science course.

Granted that a teacher is not afraid, wishes to teach science in the middle grades, and has a place for it on her program, another obstacle is encountered, namely the organization of the

subject matter or content. No two school systems have the same environment and science needs. Committees should be chosen to work out a curriculum or course of study for their respective communities. Research studies in the past few years place the reason for unsuccessful science teaching in these grades to the fact that the material has not been organized. Those engaged in these studies have done much worth-while pioneer work toward the improvement of science teaching. Scientifically, they have chosen and set up objectives on the basis of sound criteria.

Three criteria are recommended to the curriculum maker for setting up of objectives. The first criterion is: certain objectives should conform to the scientific conceptions which when understood, greatly influence the thought reaction of the individual and modify thinking. A few concepts chosen were: some forms of life are minute, man's conception of truth changes, space is vast, and species survive because of adaptation to their environment. The second criterion for setting up objectives is: certain objectives should conform to those goals that are important in establishing economy, health, and safety in private and community life. The third criterion is: certain objectives should conform to those facts, principles, generalizations and hypotheses of science which are essential to the interpretation of the common, natural phenomena in man's environment. After specific concepts and generalizations are set up, there remain certain important attitudes, skills, and appreciations which will be concomitant with the larger objectives. These criteria give the curriculum maker a basis on which to work.

After setting up the general objectives, the next step is to formulate specific objectives contained in the larger objectives. These specific objectives suggest the instructional materials and means of attaining the goals; they suggest the units of instruction which are to be chosen for each grade. Selecting the units of instruction for the different grade levels has to do with such problems as order, frequency, grade placement, and continuity.

The establishing of intermediate grade science in the Deming school ten years ago has resulted in the making of a course of study. When this teaching was first begun, the newer concept of teaching units was being introduced. Science was becoming a part of the daily teaching program in all of the elementary grades, but there was nothing to guide the teacher. Very few courses of study had been constructed. There were few text-

books for the middle grades and those that were available were of scrappy bits of material, without unity, simplified physical science was omitted, most space was still given to the natural sciences. No thought was given toward any balanced organization. Necessity was the mother of invention. At the Deming school we began to make a course of study. Many changes have been made since the time it was begun. The results of research studies, new courses of study, the Thirty-First Yearbook, children's interests, new textbooks and the immediate environment have been utilized.

The course has been organized into units. Since much of the content for these grade levels is natural science, the seasonal sequence of fall, winter, and spring units has been followed where possible. The first fall units for grades four, five, and six are insect units. Each unit treats a different theme or objective and different insects. The insect units are followed by still other fall units, Bird Migration, The Scattering of Seeds, and Trees in Fall. When possible the principle of continuity of larger units through the three grades respectively, is followed. The larger unit, "The Solar System," is divided into "The Sun," unit in grade four, "The Stars and Moon," unit in grade five, and "Planets and Visitors to the Solar System," unit in grade six. Difficulty of concepts and number of facts involved in a unit was also considered, for example; the unit "The Earth's Story" is taught in the sixth grade rather than in the fourth because of difficulty of concepts and organization of the unit. It was more difficult to use children's interest as a basis for grade placement. Children in these grades are interested in all phases of their environment. Again, we relied on the results of research. In selecting objects for identification, the plants, animals, trees, stars, flowers, natural rocks, etc. found in the immediate environment were chosen. With these principles as a basis, the Deming school course was finally completed. A list of the units chosen with their specific objectives is here given:

Units For Grade Four

Unit I—The Social Insects

Specific Objective—To learn how the work in the homes of these insects is organized and performed.

Unit II—Hibernation

Specific Objective—To learn how certain animals prepare for and spend the winter.

Unit III—Plants That Help Us

Specific Objective—To learn how we are dependent for food, clothing, shelter, etc. on the plants of garden, orchard, and field.

Unit IV—The Sun
Specific Objective—To learn the nature of the sun and how it helps us.
Unit V—The Air About Us
Specific Objective—To learn why the air is important to man and plants.
Unit VI—Magnets
Specific Objective—To learn the nature of magnets and what they can do.
Unit VII—Spiders
Specific Objective—To learn of the characteristics and habits of spiders.
Unit VIII—The Making of Soil
Specific Objective—To learn how certain natural forces have been at work through the ages making soil.
Unit IX—Making a Garden
Specific Objective—To learn how to prepare, make and care for a garden.
Unit X—Animals of the Garden
Specific Objective—To learn how the snail, earthworm, toads and frogs are fitted to their homes.

Units For Grade Five

Unit I—Insect Friends and Enemies
Specific Objective—To become acquainted with certain helpful and harmful insects, their habits, and methods of control.
Unit II—The Scattering of Seeds
Specific Objective—To learn how nature has provided for seed dispersal.
Unit III—Bird Migration
Specific Objective—To find the answer to problems involved in the travels of birds, as; why birds migrate, when certain birds leave and return, how they find their way, etc.
Unit IV—Stars and Moon
Specific Objectives—To become acquainted with the most outstanding constellations. To learn about the nature of the moon and the effects of its movements.
Unit V—Fire and Its Control
Specific Objectives—To learn why a fire burns. To learn of the causes of fires, their prevention and control.
Unit VI—Fish
Specific Objective—To learn how fish are fitted to their homes.
Unit VII—Artificial Light
Specific Objectives—To learn of the development of lamps. To learn how lamps give light.
Unit VIII—Rocks and Minerals
Specific Objective—To become acquainted with some common rocks and minerals and to learn of their value.
Unit IX—Snakes and Their Relatives
Specific Objectives—To learn how reptiles are fitted to their environment. To be able to distinguish poisonous from non-poisonous kinds.
Unit X—Flowers and Their Partners
Specific Objectives—To learn how flowers and insects are dependent on each other. To become acquainted with some common wild flowers.

Units For Grade Six

Unit I—Insects of the Household
Specific Objectives—To learn of the harm done by certain insect pests. To learn how to control these insects.
Unit II—Trees in Fall

Specific Objectives—To become acquainted with some common trees of the community. To learn of their value and care.
Unit III—Our Winter Birds
Specific Objectives—To become acquainted with the winter birds of the community. To learn of their value and care.
Unit IV—Planets and Visitors of the Solar System
Specific Objective—To learn of the interesting characteristics of the different planets and visitors to the Solar System.
Unit V—Heat and Cold
Specific Objectives—To learn how to measure heat and cold. To learn how the state of a body changes when heated or cooled.
Unit VI—Flowerless Plants
Specific Objective—To learn how mushrooms, bacteria, ferns, etc. differ from flowering plants.
Unit VII—The Sending of Messages
Specific Objective—To learn of the scientific principles involved in the development of signs, signals, and modern ways of sending messages.
Unit VIII—The Earth's Story
Specific Objective—To learn of the climatic conditions and of the animal and plant life during each of the ages of the earth.
Unit IX—The Growth of Plants
Specific Objective—To learn of the plants' needs for growth and how each part of the plant aids in its growth.
Unit X—The Weather
Specific Objective—To learn of the causes of the different kinds of weather.

The detailed content included in each unit was then worked out in the form of problems with subject matter outline. This seemed more usable than a list of outcomes in statement form. Many kinds of purposeful activities grow out of the unit material. Here again, no one can set up more than a brief list of suggested activities which will apply to all schools. Each teacher with her pupils will work cooperatively in raising problems, in suggesting activities, in planning and organizing, doing the work planned, and in evaluating the work done. There will be a need for all kinds of reference materials for the work period. Books, pictures, and constructive materials will be used but the real objects in experiment or natural setting will never be sacrificed for vicarious experience where it is at all practical or possible to utilize them.

In summarizing: it has been found that the failure of science to establish itself in the middle grades, and the unsuccessful teaching of science in these grades has been due to two main causes, (1) the teacher's lack of subject matter background and (2) the lack of organization of the content material.

These two problems can be solved by (1) simplified general science courses in teachers' colleges and (2) by the constructing of courses of study for particular communities, by committees,

for these grade levels. In constructing these courses of study the needs of the immediate environment and results of expert research studies in the field of curriculum making should be studied. General objectives, specific objectives, units of instruction with their direct and indirect outcomes and suggested activities should be set up. Problems to be considered in selecting units of instruction are order, frequency, grade placement and continuity; what has already been done will again be helpful. Objects for identification will be selected from the immediate environment.

The test of such a project is, does the course of study function in the classroom. Of course, much will depend on its acceptance and use by the individual teacher. If she has been a helper in its construction, I believe the concepts of science gained, insight into the broadness of its scope, and familiarity with the content, will result in a willingness and desire to use the course. The judging of the actual working of the science course of study is the effectiveness of the classroom teaching. If we can see a plan of the lesson or unit in the background, built on the general and specific objectives with directed children's activities, scientific thinking stimulated and outcomes applied to everyday problems and thinking, then we can say the course has functioned.

NEW OPTICAL TEST ENABLING RAPID OIL ASSAY

Oil assays, until recently expensive and time-consuming, can now be made in a few minutes, using only a few drops of oil, as a result of methods developed by Hollis D. Hedberg, geologist for the Mene Grande Oil Company of Venezuela.

The old question "What kind of oil is it?" can now be answered by looking at the oil through a refractometer, which determines the amount that the oil sample bends light rays. Each type of oil bends the rays in a characteristic manner, giving a sure indication of the oil type. Older methods measured the density of the oil, and required at least half a pint of oil for the test, as against a teaspoonful or less for the new optical method.

While an exact analysis of an oil requires a very complicated series of test distillations and other laboratory measurements, an approximate test, sufficient for ordinary use, can be made by the new optical method, which is at least as accurate as the older method of measuring the oil's density, is quicker and uses less oil.

Thinking is the hardest kind of work a mortal can do. And just because it is hardest, the higher rewards are reserved to it. For reliable conclusions thinking calls for facts; facts are found by digging. He who has gathered this wealth is well equipped for life.

THE THIRTY-SEVENTH ANNUAL CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

By Harold H. Metcalf, *Secretary*
Oak Park, River Forest High School, Oak Park, Illinois

The thirty-seventh annual convention of the Central Association of Science and Mathematics Teachers was held on November 25th and 26th in the Netherland Plaza Hotel at Cincinnati, Ohio. The exhibits were extensive and well planned. Ample room was provided for all of the meetings and an atmosphere of good will persisted throughout the convention. It is impossible to mention all who took part in planning but tribute is paid to President W. R. Teeters, Committee Chairmen Ada Weckel, Clayton M. Howe, W. Harold Evans, E. W. Christy, C. J. Brubaker, Adelaide Sanders, Kenneth Vordenberg, Edith Fox, A. C. Taylor, Marie S. Wilcox, Walter G. Gingery, and to all who served on the committees or took part in the program.

The Board of Directors was kept busy at meetings held on the evening of November 24th, after the banquet on November 25th, and at noon on November 26th. Those members in attendance were: President Teeters, E. O. Bower, O. D. Frank, Walter G. Gingery, J. S. Georges, Marie S. Wilcox, N. A. Neal, H. C. Krenerick, Theodore D. Kelsey, Ira Davis, C. J. Leonard, Ersie Martin for Walter J. Carnahan, Vice President R. B. Simon, and Secretary Harold H. Metcalf.

THE FRIDAY MORNING GENERAL SESSION

It should be said at the outset that the music provided for the various meetings by the pupils of the Cincinnati schools was exceptionally fine. Members continued to comment on one or another of the musical numbers heard and to compliment those who were responsible for the high grade of entertainment offered. President W. R. Teeters presided and called upon Superintendent of Cincinnati Schools, Claude V. Courter, who cordially welcomed the Association to Cincinnati. That welcome was manifested in an abundance of ways throughout the convention. Theodore Kelsey represented the Association in thanking the Cincinnati teachers for the opportunity provided by them for such a meeting.

The report of the speeches given at the various meetings is brief because most of the manuscripts will be printed in this and in other issues of the Journal.

Professor Louis Brand of Cincinnati University talked on The Significance of Mathematics in Science and Art. He pointed out that although music is not an exact science, all chords are determined precisely by mathematics. Space and time studies in science involve the use of algebra and geometry. Spectroscopy, in which not only the visible but also the ultra violet and the infra red ends of the spectrum are studied carefully, demands extensive use of mathematics. The determination and measurement of all constants in nature is dependent on mathematics. The mathematician is always ready to provide the tools for the interpretation of newly discovered scientific phenomenon.

Dr. John A. Swenson of Columbia University compared the new type of mathematics with the old. He outlined the history of a movement started at a conference held in Rome in 1908 and which finally resulted in a committee report in 1923. Statistics and calculus were recommended for the 12th year but mathematics teachers were not prepared to teach calculus even though the pupils were ready for it. The social sciences which

have been introduced demand a mathematical background not afforded by the present curriculum. Strength is found wanting in the present American curriculum in mathematics due to a lack of concepts, a lack of continuity, and a lack of proper time element.

Dr. J. Paul Visscher of Western Reserve University gave a very interesting talk on his Hawaiian experiences. The Islands are new in the sense that they are constantly being transformed by the lava of volcanic eruptions and new in the sense that they were discovered less than one hundred years ago. Hawaii is 2000 miles away from the nearest main land and was unquestionably never connected with any continent. Biologically, they are new since the flora and the fauna have not been naturally dispersed. Economically, the Islands have developed with great rapidity. Ninety per cent of the pineapple used in the world is grown there and over one hundred tons of fine quality of sugar is produced yearly.

Of more than ten thousand islands in the group, only seven are inhabited. Each island is dependent on the mountains for its water supply and only on these seven are the mountains high enough to condense the water vapor of the atmosphere.

Dr. Visscher not only made his talk very interesting but he also illustrated it with three reels of Kodachrome film which showed the types of vegetation, animal life, sea life, island scenery, and industries.

BIOLOGY SECTION

The biology section was called to order November 26, 1937 at 2:00 P.M. by the chairman, John W. Kendrick. The secretary, Lillian Bondurant, and vice chairman, Harold W. Evans, were also present.

The nominating committee consisting of the following members, O. D. Frank, R. B. Simon, and Hildegard Pieper, was appointed by the chairman.

The first speaker was Mr. O. D. Frank of the University of Chicago who spoke on the subject of That Reminds Me. Since boys and girls are natural, teachers should be natural in teaching them. Teachers should be salesmen but their products must not be *dry goods*. Children often make discoveries of importance which is illustrated by the boy who, through observation, learned that the ivy leaves fell before the stems. Further investigation disclosed that the same phenomenon was characteristic of the Ailanthus and on some species of Ash. Dr. Frank spoke of his famous *Beto* books in which the pupils makes notes on some Biology, Experience, Thought, or Opportunity that has occurred in his everyday life. The books are collected at the end of each week. The speaker had secured Miss Hester Stephenson of the Cincinnati Park Service who told of nature trails and trailside work. At the museum during the time approaching Christmas, tree ornaments were being made from what was found on tramps through the woods. These ornaments were to be used to decorate a tree at one of the hospitals. The variety of characters and quaint figures made from various seeds and seed pods was a surprise to everyone.

Forests and Floods was the subject chosen by Mr. Stanley F. Wilson, the next speaker. Mr. Wilson is the Associate Regional Forester, Milwaukee, Wisconsin. His paper will appear in this or a subsequent issue of the Journal. The speaker pointed out that a flood is like an epidemic; the time to stop it is before it begins. Unchecked erosion means loss to everyone. What makes up the wealth of fields and forests higher up, becomes an agency of destruction in the country lower down. In the middle west, most of our difficulties are from deforestation, the farming of submarginal lands which might be better in woodlands, poor farming methods and fire. In the virgin forests, fires are more easily prevented and controlled

because of the large amount of moisture and little wind. Forest land must get back into forest cover. Progress has been made in the lake region and southern states where 90% of the planting is now being done.

The report of the nominating committee was as follows: Chairman, Lillian Bondurant, Oak Park, River Forest High School; Vice Chairman, Harold W. Evans, Hartwell High School, Cincinnati, Ohio; Secretary, Esther D. Olsen, Kelley Senior High School, Chicago, Iillinois. The report was accepted.

Mr. A. S. Windsor of the General Biological Supply House, Chicago, Illinois, spoke on Ant Study in The Biology Classroom. The paper will appear in this or a later issue of the Journal. In introducing this study of ants to the pupil, it is best to start out in the field if possible. For laboratory observations, an ant home can be constructed or one of the many available types can be obtained. Observations likely to be made which will captivate student interest and insure success for the study are described in the paper.

LILLIAN BONDURANT, *Secretary*

CHEMISTRY SECTION

The chairman, Jesse L. VanHorn, called the meeting to order at 2:00 P.M. and appointed a nominating committee of the following members: Ray C. Soliday, Theo. D. Kelsey, and Allan Stacy.

Miss Ernistine Long, secretary, read the paper prepared by Harold W. Baker of Rhodes High School of Cleveland who was unable to be present. A thorough analysis of the mathematical problems essential for first year chemistry showed that only the following skills were required: addition, subtraction, multiplication, division, decimals and percentage, ratio and proportion, and interpretation of words into number relationships. Pupils varied widely in different schools in their scores on objective tests. This same variation was noted within a large system. Remedial teaching was outlined. A complete report of this project sponsored by Neo Chemto, Northeastern Ohio Chemistry Teachers, including all lists of problems, directions, score sheets, and tables of data, may be secured from V. S. Culp of West High School of Akron, Ohio at a small cost.

Mr. Carrol C. Hall of the Springfield, Illinois High School, talked on Trends In Organization Of High School Chemistry Since 1920. A study of textbooks, state and city courses of study, and reports of various committees showed that the lack of philosophy for the American High School is reflected in the organization of high school chemistry. Shall the student be prepared for college or for life? If the purpose is for college, the content of the high school course is well defined. If the purpose of the course is that of life preparation, the problem is greater. Pandemic or cultural courses in high school chemistry organized or proposed since 1920 show great diversity: (1) the course content set up for college preparation; (2) a course organized on the basis of principles of chemistry; (3) courses dealing with the practical applications of chemistry; and (4) a course designed for consumers.

Theoretical points of view expressed in various committee reports and periodical articles have been gradually adopted in courses of study and in textbooks. There has been an application of the findings of educational and psychological research to the organization of high school chemistry. From a purely descriptive arrangement of chemistry materials of an earlier period, the topical method of organization was developed. The unit organization is now replacing the topical plan of organization. Mr. Hall called attention to many other trends. One should read the article in the

Journal for a more thorough analysis of trends in high school chemistry teaching since 1920.

The third speaker was Mr. C. C. Warren of Hughes High School of Cincinnati who discussed The Segregation of Chemistry Students As To Their Needs And Abilities. In a large high school today as well as out in society, there are individuals who cannot or at least will not do much work. For young people who will not go to college, a practical course in chemistry has been created. Such a course not only teaches facts and principles but also about the world in which we live with the result that pupils are made intelligent consumers of technical services and goods. A special effort was made to meet the needs of girls who would go into home making. A series of fifty experiments have been formulated and used.

Mr. Votaw of the Proctor and Gamble Company of Ivorydale, Ohio talked on the subject of, "Will Soaps become Old-Fashioned?" Mr. Votaw outlined the history of soap making and the development of the modern soap industry. Hymolal salts prepared by a special catalytic hydrogenation process in which fatty acids are reduced to the corresponding alcohols are used in preparing the new detergents such as Dreft and Drene. The hymolal salts have an advantage over soaps. They are more powerful sudsing agents and have other advantages.

The nominating committee presented its report which was accepted. Chairman, R. E. Whitney, Marshall High School, Chicago, Illinois. Vice Chairman, Ernestine Long, Normandy High School, St. Louis, Missouri. Secretary, Ray Harkins, Woodward High School, Cincinnati, Ohio.

ERNESTINE LONG, *Secretary*

ELEMENTARY SCIENCE SECTION

The meeting of the Elementary Science Section of the Central Association of Science and Mathematics Teachers at Cincinnati was called to order by Geraldine Shontz, chairman. The minutes of the last meeting were read by David Russell, secretary, and were unanimously approved by the group.

The nominating committee consisting of Villa B. Smith, School of Education, Cleveland, O. D. Frank, University High School, Chicago, and Elverta Hutchinson, Winthrow High School, Cincinnati, named the following as officers for 1938:

Chairman—David Russell, National College of Education, Evanston, Illinois.

Vice-chairman—Mary Melrose, Cleveland Public Schools, Cleveland, Ohio.

Secretary—Veva McAtee, Rogers Clark School, Hammond, Indiana.

The nominations of the committee were approved and accepted.

Martha Jones, Deming School, Terre Haute, Indiana, gave in brief a plan for the teaching of elementary science in the Deming School called, A Unified Science Course In Grades Four, Five, and Six.

There is no reason to again justify the importance of science in the elementary grades. This has been well established by curriculum specialists and science is now considered a very important part of the elementary school program.

In planning the course of study in science for the fourth, fifth, and sixth grades at Deming School, the off-campus school of the Indiana State Teachers College at Terre Haute, Indiana, three criteria were used to determine the objectives. The first criterion is that science in the grades should contribute to the child's everyday thinking and its concepts should be involved in making his many daily decisions. The second criterion re-

lates to the child's everyday living and third criterion suggests that science should help the child appreciate his environment and to understand the relationship of living things. With the three criteria in mind the Demine School determined their objectives and organized their units of work.

In the units the subject matter content was emphasized with purposeful activities suggested and planned by the teacher. The incidental method was considered of little value and the usual emphasis on child interests was reduced to a reasonable interpretation. The unit arrangement of subject matter is a very interesting arrangement and was presented in an excellent manner by Miss Jones. The full article is published in this issue of SCHOOL SCIENCE AND MATHEMATICS.

Bertha Stevens, Avery Coonly School, Downers Grove, Illinois, explained with projects to verify what the child could do in the first years of science. Her subject was "The First Years With Science—What Are The Goals?"

By the first years of science is meant science from the kindergarten through the third grade. In the first years of science it is important to promote three goals. The first one is the "Concept of Nature as a Whole." and is well illustrated by a quotation from Sir James Jeans in his book, *The New Background of Science*, Jeans says, "Science is only just entering its latest and most comprehensive problem—the study of the Universe as a single entity." This is further illustrated by the many other science books for the general reader calling for super scientists who can assimilate all the branches of science.

The second goal is to use direct, actual, and tangible relations with nature in daily life and especially related to the immediate environment. It is important to teach the fundamental concepts common, in general, to nature.

The third goal is an experience with nature and science that involves the child's emotions, his intellect, his imagination, and his initiative. It seems in this goal we have condensed hundreds of pages of educational theory reduced to a workable understanding. Warning was given not to hurry children but to give them time to explore, to wonder, and to be happy. Miss Stevens supplemented her talk with an exhibit illustrating a real common sense approach to teaching the first years of science. Her address was a real contribution to the meeting and was taken from many years of successful and outstanding teaching experiences. Full text will appear in a later issue of SCHOOL SCIENCE AND MATHEMATICS.

Dr. Robert B. Gordon, Ohio State University, Columbus, Ohio, gave an illustrated lecture on the values of "An Outdoor School for The Elementary Science Teacher."

For the nature study teacher the outdoors school is an excellent place for summer school training. Of the many values of outdoors schools there are three that are very important. In the outdoors school, the teacher can use informal methods of presenting facts of elementary science because nature is the background and field instruction replaces formal lectures and laboratory work. In the second place the outdoors camps are places to acquire subject matter through first hand knowledge, and thirdly the schools provide opportunities for healthful recreation and inspiration.

There are three kinds of outdoors schools for teachers. The Biological Research Stations have well trained staffs with excellent equipment but for the most part these schools cater to graduate students and specialists. In the second group are the nature study camps, and while their period of instruction is often too short, they answer a real need for teachers who have only two weeks to spend at camp. The third group includes the schools of Natural History. Many of these are sponsored by colleges and uni-

versities and are conducted on a college credit basis for a period of six to eight weeks. A list of the camps in these three groups can be secured from the General Biological Supply Company in Chicago, Illinois.

Mr. Gordon concluded his lecture with colored stereoptican slides illustrating the activities of the Allegany School of Natural History. He fully presented an excellent account of evaluating outdoors schools for nature study. The full text of the article will appear in a later issue of SCHOOL SCIENCE AND MATHEMATICS.

DAVID W. RUSSELL, *Secretary*

GENERAL SCIENCE SECTION

Carl F. Hanske, the chairman, called the meeting to order at 2:00 P.M. The secretary, Herbert A. Grabau and the vice chairman, Theodore J. Kuemmerlein, were also present.

John P. Biggs of the Rothenburg Junior High School of Cincinnati, Ohio, talked on The Penalties of Unscientific Thinking. He stressed the point that though we are living in a changing world that the world is not changing fast enough in some respects. Superstitions persist. Science teaching should emphasize the importance of searching for the truth.

Sidney Esten of the Arsenal Technical High School of Indianapolis talked on Science Broadcasts For Junior and Senior High Schools. He discussed the importance of the use of radio in connection with our teaching. Radio is used in the teaching of musical appreciation, literature, and advertising but it should increasingly be used in the science field. Mr. Esten ended by telling about his pet snake.

The nominating committee consisting of L. H. Fuller, Alma Thomas, and Ira Davis presented the following people who were accepted by vote as officers for next year. Chairman, Theodore J. Kuemmerlein of the Boys Technical High School of Milwaukee, Wisconsin; Vice Chairman, Herbert A. Grabau, Lincoln High School, Des Moines, Iowa; Secretary, Pauline Royt, Horace Mann Junior High School, West Allis, Wisconsin.

Mr. McClelland, a representative of Erpi Pictures, had for his subject, Talking Pictures for the Class Room. He showed the value of talking pictures by showing a number of films, the titles of which were; Body Defense Against Disease, Nervous System, Circulation, Poultry, Roots of Plants, and Earth in Motion.

HERBERT A. GRABAU, *Secretary*

GEOGRAPHY SECTION

The section was called to order by the chairman, Frederick J. Breeze at 2:00 P.M.

Dr. Nevin M. Fenneman of the University of Cincinnati talked on Nature's Way.

The 1938 officers were elected. Chairman, Helen Turner, Oak Park, River Forest Township High School; Vice Chairman, Frederick J. Breeze, North Side High School, Fort Wayne, Indiana; and Secretary, Ethel L. Mills, Soldan High School, St. Louis, Missouri.

Viva Dutton Martin gave an interesting talk on the Bridges National Monument of Southeastern Utah. She illustrated her talk by means of photographs which she had taken while on a trip to the monument last summer.

An interesting round table discussion took place on the subject of whether the next forward step in high school geography would be physical or economic.

FREDERICK J. BREEZE, *Acting Secretary*

MATHEMATICS SECTION

The mathematics section was called to order by Vivian B. Ely. Miss Eleanor Booher, the secretary, and Harold E. Spross, the vice chairman, were also present.

Mr. David W. Russell of the National College of Education of Evanston, Illinois presented a paper on Experiencing Some Mathematical Concepts in Junior High School.

Mr. Russell introduced his talk by emphasizing that mathematics in the junior high school must be functional and related to abstractions as well as simple calculation of second hand problems. He presented his plan of teaching these abstractions and application by using a series of "mathematical" pictures that he had taken while vacationing last summer and made into slides. The pictures showed clearly how calculation, perspective, design, mathematical planning, and other concepts, are applied in transportation, construction, power development, recreation, and other phases of human activity. The junior high school children were asked to write mathematical essays on the arithmetic involved in the pictures and from these "living" problems were designed to involve the calculation and understanding of functional arithmetic.

One outcome of the plan was an insurance company organized in the school by the eighth grade class. He illustrated with children made lantern slides the understanding they had developed between mathematics and problems in everyday survival. In conclusion he described the development of the "mathematics" laboratory in which current problems of mathematics were carried on with the use of mathematical machines. Adding machines, slide rule, protractors, and other instruments are used with problems being made complex enough to require an understanding as well as a mechanical approach. He concluded by warning that mathematics will not be taken from the curriculum if it is made alive, for active and living mathematics is one of the most interesting "subjects" to teach and can be one of the most interesting activities in the junior high school curriculum.

The nominating committee consisting of C. J. Leonard, Eleanor Booher, and Joseph Kettery made its report which was accepted by unanimous vote. Chairman, Harold E. Spross, Central High School, St. Louis, Mo. Vice Chairman, J. J. Urbancek, Lane Technical High School, Chicago, Illinois. Secretary, Miss Ida D. Fogelson, Bowen High School, Chicago, Ill.

Professor John A. Swenson of Columbia University discussed the Algebraic Treatment of Euclidean Geometry. He is the author of *Integrated Mathematics*.

The core of the ninth year mathematics at the Andrew Jackson High School, New York City, is a simplified type of analytical geometry. The work begins with the remarkable mathematical method which occurred to the French philosopher Descartes in the beginning of the 17th century: the setting up of a one-to-one correspondence between numbers and the points on a line.

In this manner, there is established a system of coördinates on a line and a fairly complete analytical geometry of one-dimension is brought about, dealing with such topics as: directed line-segments, loci, distance formula in one dimension, finding the coördinates of the points which bisect, trisect, etc. given line-segments, complete and partial converses of theorems, positive and negative numbers, transformation of coördinates, arithmetic mean by using an assumed mean.

This is followed by the introduction of such geometric concepts as:

(a) extending, rotating, and translating line-segments, (b) angles, their supplements and complements, (c) polygons, (d) algebraic problems involving these geometric concepts.

Next an analytical geometry of two dimensions is established by setting up a one-to-one correspondence between points in the plane and ordered pairs of numbers. The following fundamental assumption is made: two perpendicular lines and all the lines perpendicular to them form a network of rectangles. The fact that the graph of an equation of the first degree in one or two unknowns is a straight line is verified experimentally but a logical proof is of course impossible at this stage. It is also verified experimentally that a straight line has a constant slope or difference ratio. Hence the last two facts are listed as assumptions. The delta notation is also introduced at this stage.

A modified form of the three congruence theorems is now introduced. The first one (s.a.s.) is verified experimentally, but the second and the third are proved by the indirect method.

The parallel line theorems are proved by using slopes or difference ratios.

By introducing oblique networks, the work with triangles and parallelograms is considerably simplified, and leads to the following basic theorem: If a line parallel to one side of a triangle cuts the other two sides, any two segments on one side have the same ratio as the two corresponding segments on the other side.

This readily leads to similar figures and trigonometry.

Note. The algebra is introduced as needed.

Professor Tibro Rado of Ohio State University talked on the subject of High Schools in Pre-war Central Europe. He contrasted the procedure for handling the work of the secondary schools of pre-war Europe (Germany, Austria, and Hungary) with that in America. He emphasized the fact that students in these Central European Countries who were capable of profiting by academic training were segregated from the others. At any time that the work of a pupil fell below the standard set he was dropped to a lower educational level. Pupils made every effort of which they were capable because failure meant demotion to a lower social class.

Because educational advantages after the twelfth year were not offered at public expense, pupils were keenly appreciative of their opportunities.

In conclusion, Professor Rado stressed the point that any educational system should be appraised by its results in producing leaders and an enlightened citizenry. By this standard, the states of Central Europe, now dictatorships, fall short.

ELEANOR BOOHER, *Secretary*

PHYSICS SECTION

The physics section was called to order at 2:00 P.M. by the chairman, N. A. Neal, the secretary, James P. Fitzwater, also being present.

Mr. Ralph Haile of Cincinnati represented Mr. W. F. Kruse of the Bell and Howell Company and read his paper, The Motion Picture as a Science Teacher. The point was made that the motion picture is an additional tool for the teacher but not a substitute. A worthy motion picture film, properly used by any instructor, will be found an invaluable science "teacher."

Dr. M. N. States of the Central Scientific Company read a paper on the subject, A Cultural Course in Physics is a Practical Course. The student is given a clear idea of requirements. Definite assignments and

scope of course are clearly outlined. Library facilities are widely used. Students elect such a course from other than scientific fields.

Dr. Joseph N. Synnerdahl, St. Xavier College, Chicago, Illinois, made a Defense For Survey Courses in The Junior College. The case of the junior college is predicated on these two theses: (1) Just how valid are these lines of attack that are being made upon the general education from the specialist approach?, (2) How successful may we be in our search for these integrating principles about which we can build a significant educational offering, if we consider subject matter not per se, but rather with reference to their very great significant outcomes.

The nominating committee consisting of H. Clyde Krenerick, Ernest O. Bower, and C. M. Howe, made its report which was accepted. Chairman, James P. Fitzwater, Lakeview High School, Chicago, Illinois; Vice Chairman, Ersie S. Martin, Arsenal Technical High School, Indianapolis, Indianapolis, Indiana; Secretary, Ray Lambert, Walnut Hills High School, Cincinnati, Ohio.

JAMES P. FITZWATER, *Secretary*

THE ANNUAL RECEPTION AND ANNUAL DINNER

The textbook and apparatus exhibits were very well planned and attracted much interest. There was ample room for each display so that the men in charge could demonstrate apparatus to interested teachers.

Miss Edith Fox and Miss Adelaide Sanders are to be congratulated on the good fellowship that was evidenced during the reception and banquet. It was a novel idea to have a hostess for each table for it led to a feeling of ease and friendliness.

The Withrow Trombone Quartet was enjoyed. The high light of the music of the convention was the Walnut Hills a capella Choir; people were heard to comment afterward on the beautiful singing.

Dr. Henry F. Kock, the toastmaster, kept things moving so that there was not a dull moment during the evening. Short talks were made by W. R. Teeters, Clayton M. Howe, Claude V. Courter, Franklin T. Jones, E. W. Christy, R. B. Simon, and Harold H. Metcalf.

Supt. John L. Bracken of Clayton, Missouri gave the address of the evening which was full of good wit, sound ideas, and a word of warning against that type of education which called for accepting ideas as presented by teachers and books without consideration of their worth or truth. Youth must learn to challenge thoughtfully the conventional ideas and institutions in order to truly discover their worth or faults and in order to become a valuable member of society later on. The scientific method of approach to the solving of problems was highly praised by Mr. Bracken.

ANNUAL BUSINESS MEETING

The Annual Business Meeting was called to order at 8:30 A.M. by President W. R. Teeters.

Mr. Ersie Martin gave the Necrology report in which he talked at some length of the great service that Mr. Charles M. Turton had rendered the Association and of the untimely death of Mr. Turton on Thanksgiving eve. This issue of the Journal carries a testimonial to Mr. Turton. We all will miss him. Mr. Martin told of the passing of Herbert Slaught, Frank O. Kruh, C. E. Linebarger, and Louis E. Hildebrand.

Mrs. Wilcox, as chairman of the membership committee, gave the report in which she told of efforts to bring the Cincinnati Convention to the attention of other groups, of the work of the various state chairmen

in encouraging membership in the Association, and of the number of members in the Association. The report was accepted.

Mr. Gingery gave the report of the auditing committee which found the books of the treasurer, Harold H. Metcalf, in excellent condition.

Mr. Gingery, chairman of the nominating committee, gave the report which recommended the following officers for the Association Board of Directors, terms to expire in 1940: J. S. Georges, Wright Jr. College, Chicago, Illinois; Marie Sangernebo Wilcox, George Washington High School, Indianapolis, Indiana; Ersie S. Martin, Arsenal Technical High School, Indianapolis, Indiana; Clayton M. Howe, Withrow High School, Cincinnati, Ohio. To replace Mr. Ira Davis on Board of Directors: George E. Hawkins, University of Chicago High School, Chicago, Illinois.

For President, Ira Davis, University of Wisconsin High School, Madison, Wisconsin.

For Vice President, Jacob M. Kinney, Wilson Junior College, Chicago, Illinois.

The report of the nominating committee was voted upon and accepted.

Mr. Ira Davis accepted the responsibility and thanked the members for their confidence in him. He promised to do his best to make 1938 a great year for the Association.

Mr. O. D. Frank gave the report of the conservation committee. The full report is printed in this issue.

Mr. Fitzwater gave the report of the resolutions committee which was accepted and is included in this report.

Mr. Franklin Jones, president of the Association in 1908, outlined a plan of planting trees along the highways and streets, the planting done by the individual land owner, but an allowance made in the tax on such property in order to encourage planting. Mr. Jones thought that all of us could help conserve our natural resources if we took an interest in such projects.

Dr. Visscher of Western Reserve University invited members to attend an outdoor meeting on the 30th of April in 1938. More will be printed in later issues about this meeting.

Mr. Ira Davis gave the report of the place of meeting committee in which he stated that, although Indianapolis, Milwaukee, and Chicago all wanted the convention, that Chicago promised to cooperate in every way to make the 1938 convention a success and had been the choice of the committee.

Mr. Gingery gave the Journal report in which he stated that it was the opinion of the committee that the general tone of the Journal had been higher, that more money had been spent in improvement of the Journal, that the last debentures had been paid, and that there should be great satisfaction in its going along as it has been going. The editor, Dr. Glen W. Warner, and the business manager, Mr. W. F. Roecker, were both highly commended for their work in maintaining the Journal on so high a standard.

Mr. W. F. Roecker gave the year book report in which he stated that enough advertising space had been sold to pay for the cost of printing and leave a small surplus.

Mr. Franklin Jones moved and it was seconded and carried that the newly elected officers be instructed to prepare proper resolutions to Mr. Turton and Mr. Linebarger appropriate to their contributions to the teaching profession and to the Journal.

The business meeting was adjourned. All committee reports had been accepted as presented.

THE SATURDAY MORNING MEETING

Vice president R. B. Simon presided at the meeting. The Hughes High School Boy's Quartet offered a number of selections which were well received.

Dr. Charles N. Moore, of the University of Cincinnati, read a very interesting paper on the subject of Mathematics and Science. Dr. Moore presented some rather novel ideas and his paper ought to be read in full to be appreciated. One interesting fact brought out was that a mathematical relationship had been worked out between the area of a wound and healing time. A variance from the normal healing time could be used to discover infection before any other symptoms would be evident.

George L. Bush of the South Side High School of Cleveland, Ohio discussed the subject of Practical Science For Advanced High School Students. He declared that science should be made available to more pupils. Speaking of the senior science course in his high school, he said that it differed from the usual physics or chemistry in three ways. It cuts completely across the common subject matter lines, stressing practical applications rather than abstract ideas. It aims rather strongly toward giving scientific consumer education. It directs special attention to the social implications of the subject matter.

The speaker estimated that about 55% of the school population would work at jobs such as truckers, railroaders, factory and laundry workers, firemen, policemen, etc. It is essential that students leave our high schools with an intimate knowledge and appreciation of the part that science will have in their lives and in the lives of all of us.

Charles S. Webb, Beaumont High School, St. Louis, Missouri, read a paper on the Teaching of Advanced Science by the Demonstration Method. This method grew out of the depression in which it became necessary to use one set of apparatus for many students. The pupils in the rear of the room, however, often missed out on the principles because they could not see what was going on. The speaker stressed the necessity of making striking demonstrations on a large scale. He stated that a new physics and a new chemistry were in the process of evolution.

A very interesting discussion followed in which a large number of those present took part.

THE SATURDAY AFTERNOON MEETING OF THE OFFICERS

All section officers and members of the Board of Directors had lunch together at noon. Plans were made for getting the right kind of a start for the convention to be held in 1938.

A formal meeting of the Board of Directors was held immediately after the luncheon. W. R. Teeters thanked all those who had helped him in making the 1937 meeting a success. He suggested that the Board hold more meetings during the year rather than to try to dispose of the business of a whole year at the time of the Annual Convention. He turned the meeting over to Ira Davis whom he termed a grand new president.

It was moved, seconded, and carried that Harold H. Metcalf be re-elected secretary and treasurer for the coming year.

Mr. Davis stated that he hoped for suggestions from Board members; that he hoped for suggestions as to the formation of an educational policy; that he felt that our Association ought to become a more positive factor in influencing the teaching of science and mathematics in this country; and that there were serious problems existing in the upper high school levels in both the teaching of mathematics and of science which our Association ought to recognize and help solve.

Mrs. Wilcox introduced the question of changing the type of *YEAR-BOOK*. This had been brought to the attention of the Board at a previous meeting by Mr. Georges. Mr. Kinney and a number of other Board members made rather a vigorous defense of the *YEAR BOOK*. No action was taken.

Mr. Metcalf thanked the Board for its courteous treatment of him and stated that he hoped to carry his responsibility in a satisfactory way during the coming year.

The combined report is respectfully submitted.

HAROLD H. METCALF, *Secretary*

REPORT OF THE RESOLUTIONS COMMITTEE

It is the desire of the members of the Central Association of Science and Mathematics Teachers assembled here at this their thirty-seventh annual convention to give this their statement of their appreciation for the untiring efforts and interests of those who have planned and carried forward to this successful termination the work of this meeting for study, inspiration, and advancement of teaching.

Therefore, be it resolved that the members of this organization give expression of gratitude:

First, To President Wm. R. Teeters, and his associates for the part they have had in planning this successful meeting.

Second, To the Cincinnati Local Arrangements Committee; to Mr. C. M. Howe and the chairman of the local sub-committees, to the teachers of Cincinnati for their hospitality; to Miss Fox and the reception committee; and to Miss Sanders and her committee which provided the many beautiful flowers and made such a success of our annual dinner.

Third, To the editor of the Journal, SCHOOL SCIENCE AND MATHEMATICS, and his staff; the business manager and his staff, for providing us with a successful magazine of helpful articles each month.

Fourth, To the *YEAR BOOK* committee for their splendid work.

Fifth, To the Hotel Netherland Plaza and Mr. Ryan, the convention chairman, for the generous cooperation and service afforded us during the convention.

Sixth, To the speakers, musicians, and entertainers who contributed so generously to the pleasure of those attending the convention.

Seventh, To the press for making it possible for a larger number of friends to know about this convention.

Eighth, To the exhibitors at the convention for their instructive exhibits.

Ninth, To the advertisers in the *YEAR BOOK* for their contribution to the *YEAR BOOK*.

Tenth, To the membership committee for their splendid work.

Eleventh, To Mr. Turner and the Cincinnati Chamber of Commerce for their interest in promoting this convention and the services of their registration experts.

Respectfully submitted by the Resolutions Committee

JAMES P. FITZWATER, *Chairman*

REPORT OF THE CONSERVATION COMMITTEE OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

Members of the Committee: Wm. G. Vinal, Massachusetts State College, Amherst, Massachusetts; O. D. Frank, School of Education, University of Chicago, Chicago, Illinois; J. L. Cooprider, Central High School, Evansville, Indiana; W. R. Teeters, Board of Education Building, St.

Louis, Missouri; Louis E. Hildebrand, New Trier High School, Kennilworth, Illinois; L. F. Pinkus, Sigel School, St. Louis, Missouri; Fred Schriever, Chairman, Boys' Technical High School, Milwaukee, Wisconsin.

This committee, appointed November 29th, 1930, has made six reports of its findings. With some change in membership, the committee is to continue the study of the question of Conservation Education in the Secondary School curriculum.

A. The Progress of Conservation. The conservation idea is gaining ground in the individual states and throughout the nation.

In Wisconsin, for example, in accordance with the Conservation Education Law of 1935, an excellent bulletin has been put out this year by the Department of Public Instruction entitled, "Teaching Conservation in Wisconsin Schools."

A companion bulletin is in preparation which will contain a bibliography of reading materials by grades and a list of activities. Material is being accumulated for teaching units, and teachers are encouraged to help.

B. Conservation Activity. Individual members of the Conservation Committee are doing good work.—In addition to the regular work, various members also carried on considerable discussion in regard to the national Administration's Reorganization Bill, introduced as Senate Bill 2970.

The American Forestry Association pointed out that this bill would be harmful to the Forest Service, to the Biological Survey, to the Soil Conservation Service, and to conservation interests in general, and, in addition, would practically abolish the Civil Service.

The enclosed bulletin from the American Forestry Association explains the situation.

C. Conclusions. The findings and conclusions of the committee have been given in the previous reports. We shall mention only three:

1. Conservation should, and may easily, be correlated with other subjects—it need not be taught separately.

2. Every school should take an interest in some phase of conservation, even though it be but little. Schools should avail themselves more of help to be derived from local, State, and Federal conservation agencies.

3. Conservation is not conversation; it is a way of life. It must be learned and promoted by performance rather than by reading or discussion. It is a wholesome combination of study and activity.

Respectfully submitted.

FRED SCHRIEVER, *Chairman*

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting, and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India Ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1507. *C. N. Mills, Normal, Ill., Edwin W. Bailey, Delta, Pa.*

1508. *David Rappaport, Chicago,*

1513. *R. W. Schmied, University of Texas.*

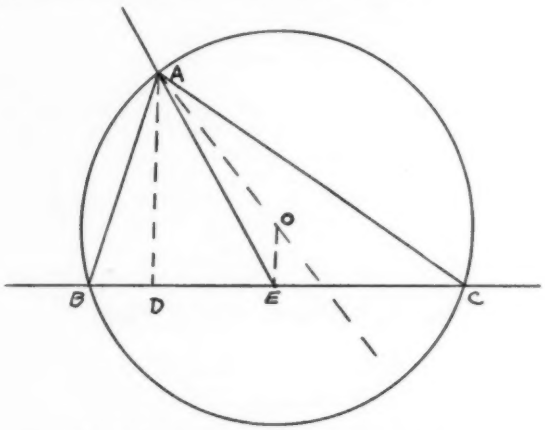
1502, 4, 6. *Edwin W. Bailey, Delta, Pa.*

1513. *Kenneth P. Kidd, Tallahassee, Florida.*

1512. *William W. Taylor, Port Arthur, Texas.*

1514. *Proposed by William W. Taylor, Port Arthur.*

Construct a triangle, given the difference of the base angles, the difference of the angles made by the median to the base, and the difference of the projections of the other two sides upon the base.



Solution by H. R. Mutch, Glen Rock, Pa.

Since the sum and difference of the angles made by the median to the base are known, these angles can be found, and the median line can thus be drawn. The projections may be written $P = BE - ED$ and $P' = CE + ED$, hence $P - P' = 2ED$, and since this is known, point D is thus located, and perpendicular at D will locate the vertex A.

By the well known theorem that the difference of the base angles equals the angle formed by the altitude and circumdiameter through the same vertex, the line through the circumcenter may be drawn. The circumcenter is then located by erecting the perpendicular at E. The intersection, o, is the circumcenter, which determines the circumradius. The circumcircle will then locate vertices B and C.

Solutions were also offered by A. Mac Neish, Chicago, Aaron Buchman, Buffalo, N. Y., James A. Lemon, Eaton, Ohio, D. L. MacKay, New York, N. Y., and by the proposer.

1515. *Proposed by G. S. N. Ayyar, Tiruvilwamala, India.*

If x be a proper fraction, show that

$$\frac{x}{1-x^2}-\frac{x^3}{1-x^6}+\frac{x^5}{1-x^{10}}-\cdots=\frac{x}{1+x^2}+\frac{x^3}{1+x^6}+\frac{x^5}{1+x^{10}}+\cdots.$$

Solution by the proposer.

By expansion the left-hand member becomes

$$\begin{aligned}
&x+x^3+x^5+x^7+\cdots\\
&-x^3-x^9-x^{15}-x^{21}-\cdots\\
&+x^5+x^{15}+x^{25}+x^{35}+\cdots\\
&-x^7-x^{21}-x^{35}-x^{49}-\cdots\\
&\cdots\cdots\cdots\cdots.
\end{aligned}$$

Then, by adding the vertical columns, we obtain the expansion of the fractions of the right-hand member.

1516. *Proposed by Aaron Buchman, Buffalo, N. Y.*

Let each integer in the series from 1 to n be multiplied by the same of the positive integers less than it. Prove that the sum of these products has the form

$$\frac{(n-1)n(n+1)}{4!}(3n+2).$$

Solution by the proposer.

Let S_n be the given sum

Then
$$S_n=\frac{(n-1)n(n+1)}{4!}(3n+2). \tag{1}$$

Now (1) is easily verified for $n=1, 2, 3$, etc.
Assume (1) is true for $n=k$

Then
$$S_k=\frac{(k-1)k(k+1)}{4!}(3k+2). \tag{2}$$

Add $(k+1)[k+(k-1)+\cdots+1]=\frac{(k+1)^2k}{2}$ to each side of (2),

and
$$S_{k+1}=\frac{(k-1)k(k+1)}{4!}(3k+2)+\frac{(k+1)^2k}{2}$$

or
$$S_{k+1}=\frac{k(k-1)}{4}[(k-1)(3k+2)+12(k+1)]$$

and
$$S_{k+1}=\frac{k(k+1)(k+2)}{4!}(3[k+1]+2). \tag{3}$$

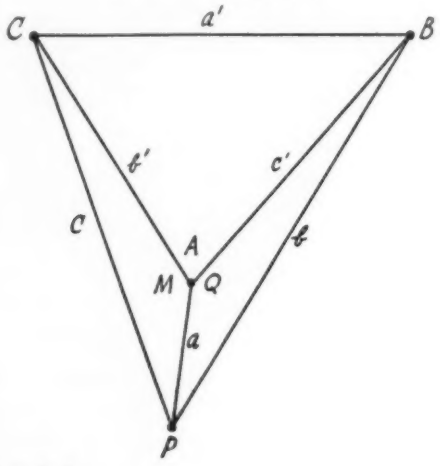
But (3) is (2) with k replaced by $(k+1)$. Therefore (1) is true for all positive values of n.

A solution was also offered by Norman Greenspan, Brooklyn, N. Y.

1517. *Proposed by A. R. Haynes, Tacoma, Wash.*

Given angles A and B of $\triangle ABC$ and distances a, b, c, to the extremities of $\triangle ABC$ from P, a point nearest A but outside the triangle. Find $a'(BC)$, $b'(AC)$ and $c'(AB)$, the sides of the triangle.

Solution by the proposer.



To find a', b' and c',

$$b'=c'\frac{\sin B}{\sin C}=c'\frac{\sin B}{\sin (A+B)}=rc' \quad \text{where} \quad r=\frac{\sin B}{\sin (A+B)} \tag{1}$$

$$\cos Q=\frac{a^2+c'^2-b^2}{2ac'} \tag{2}$$

$$\cos M=\frac{a^2+b'^2-c^2}{2ab'}=\frac{a^2+r^2c'^2-c^2}{2arc'}. \tag{3}$$

Since $M+Q+A=360°$

$$\cos^2 M+\cos^2 Q+\cos^2 A=1-2\cos M\cos Q\cos A. \tag{4}$$

By substituting $\cos^2 A=1-\sin^2 A$ in (4)

$$\cos^2 M+\cos^2 Q-2\cos M\cos Q\cos A=\sin^2 A. \tag{5}$$

Let $a^2-b^2=k$ and $a^2-c^2=m$, then from (2) and (3)

$$\cos Q=\frac{k+c'^2}{2ac'} \text{ and } \cos M=\frac{m+r^2c'^2}{2arc'}. \tag{6}$$

Substitute (6) in (5)

$$\left(\frac{k+c'^2}{2ac'}\right)^2+\left(\frac{m+r^2c'^2}{2arc'}\right)^2-2\left(\frac{k+c'^2}{2ac'}\right)\left(\frac{m+r^2c'^2}{2arc'}\right)\cos A=\sin^2 A. \tag{7}$$

Expanding and collection terms

$$A'c'^2+B'c'^2+C'=0 \quad \text{where} \quad A'=r^2(1+r^2-2r\cos A), \tag{8}$$
$$B'=2r[r(k+m)-\cos A(m+r^2k)-2a^2r\sin^2 A]$$
$$C'=r^2k^2+m^2-2rkm\cos A.$$

From (8)

$$c'=\sqrt{\frac{-B'\pm\sqrt{B'^2-4A'C'}}{2A'}}, \tag{9}$$

where the $(+)$ sign is used if P lies within the triangle, and the $(-)$ sign if it is without as given.

From (1) if
$$s=\frac{\sin A}{\sin (A+B)},$$
$$b'=rc', \quad \text{and} \quad a'=sc'.$$

Since A', B', C', r, k, and m are given in terms of known quantities, the values of a', b', c' are known.

Editor's Note: Mr. Haynes, actually set up a numerical problem and completely solved the triangle ABC. My salute to him for his patience and endurance!

A solution was also offered by D. L. MacKay, New York.

1518. *Proposed by A. R. Haynes, Tacoma, Wash.*

Prove by transformation formulae:

$$\csc 30°+\csc 45°=\tfrac{1}{2}(\tan 82\tfrac{1}{2}°-\tan 37\tfrac{1}{2}°).$$

Solution by the proposer.

$$\begin{aligned}(\tan 87\tfrac{1}{2}-\tan 37\tfrac{1}{2})&=\cot 7\tfrac{1}{2}-\tan (45-7\tfrac{1}{2})\\ &=\frac{1}{\tan 7\tfrac{1}{2}}-\left(\frac{1-\tan 7\tfrac{1}{2}}{1+\tan 7\tfrac{1}{2}}\right)\\ &=\frac{1+\tan^2 7\tfrac{1}{2}}{\tan 7\tfrac{1}{2}(1+\tan 7\tfrac{1}{2})}\\ &=\frac{\sec^2 7\tfrac{1}{2}}{\tan 7\tfrac{1}{2}+\tan^2 7\tfrac{1}{2}}\\ &=\frac{1}{\sin 7\tfrac{1}{2}\cos 7\tfrac{1}{2}+\sin^2 7\tfrac{1}{2}}\\ &=\frac{1}{\tfrac{1}{2}\sin 15+\sin^2 7\tfrac{1}{2}}\\ &=\frac{2}{\sin 15+2\sin^2 7\tfrac{1}{2}}\\ &=\frac{2}{\sin 15+1-\cos 15}.\end{aligned}$$

In solution 1496 of October, 1937 issue, it is shown that

$$\begin{aligned}\frac{1}{1+\sin 15-\cos 15}&=\frac{1}{\sin 30}+\frac{1}{\sin 45}\\ &=\operatorname{esc} 30+\csc 45°.\end{aligned}$$

Hence the given relations are shown to be true.

A solution was also offered by Walter R. Warne, New York, and A. Mac Neish, Chicago.

1519. *Proposed by Hugo Brandt, Chicago.*

A family of circles on one side of a given line are tangent to the line at a fixed point. On each circle two points are determined whose distances from the line is $(d-e)$, d being the variable diameter of the circle and e, a fixed constant. Find the locus of the variable points.

Solution by Julius H. Hlavaty, New York City.

Let the given point be the origin and the given line the x-axis. Then the equation of the family of circles is

$$x^2+y^2-yd=0$$

where d is the parameter, positive or negative.

The equation of the lines which determine pairs of points of the locus are

$$y=d-e.$$

Eliminating the variable d we have

$$x^2=ye$$

the equation of the required locus. The locus consists of two parabolas, tangent to each other and to the given line at the given point, and having foci at distances $e/2$ above tand below the given line on the perpendicular to the given line at the given point.

Solutions were also offered by H. R. Mutch, Glen Rock, Pa., Aaron Buchman, Buffalo, N. Y., and the proposer.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

1513. *Joe Ross, Franklin High School, Portland, Ore.*

1516. *Mathematics Honor Society, Monticello, Ill., Community High School.*

SOLUTIONS FOR SOLUTION

1532. *Proposed by W. R. Smith, Lewis Institution, Chicago.*

What is the longest rectangle one foot wide which can be cut from a circular sector which is the surface of a cone whose slant height is 10 ft., and altitude 3 ft.?

1533. *Proposed by Walter R. Warne, New York University.*

Eliminate θ from the equations

$$a\cos^2\theta+b\sin^2\theta=c$$

$$b\cos^2\theta+a\sin^2\theta=d.$$

Note. This problem is found in Loney's Trigonometry, p. 292.

1534. *Proposed by Mary R. Jones, Tulsa, Okla.*

Find the area of the loop of the folium $x^3+y^3=3xy$.

1535. *Proposed by Nathan Altshiller-Court, University of Oklahoma.*

Through a given point to draw a line through the inaccessible center of a given sphere.

1536. *Proposed by Walter R. Warne, New York, University.*
Solve the system for x, y, z.

$$x^2+y+z=21$$
$$x^2+yz=22$$
$$x^2yz=96.$$

1537. *Proposed by William W. Taylor.*
Construct a triangle, given the difference of the base angles, the difference of the projections of the two sides upon the base and the difference of the exradius relative to the base and the inradius.

SCIENCE QUESTIONS

January, 1938

Conducted by Franklin T. Jones

(Send all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E. Cleveland, Ohio.)

Readers are invited to co-operate by proposing questions for discussion or problems for solution.

Examination papers, tests, and interesting scientific happenings are very much desired. Please enclose material in an envelope and mail to Franklin T. Jones, 10109 Wilbur Ave., Cleveland, Ohio. Thanks!

Your classes and yourself are invited to join the GQRA (Guild Question Raisers and Answerers). More than 200 others have already been admitted to membership by answering a question or proposing one that is published.

BECOME MEMBERS OF THE *GQRA*

THE MAGDEBURG HEMISPHERES

819. *Question and Comments by James A. Lemon, GQRA No. 142, Eaton High School, Eaton, Ohio.*

"How many horses were used to separate the Magdeburg hemispheres?"

"In my work in General Science the subject of the Magdeburg hemispheres has naturally been stressed as an example of the force of air. My reference sources have given me contradictory facts concerning the number of horses used by Otto von Guericke in his experiment with the Magdeburg hemispheres."

(What information have our readers on this subject? Send in the information as you find it and then we will try to go back into history far enough to find out.

It might be worth while for some of our mathematically inclined physicists to take the size of the hemispheres, the expected pull of a team of horses, and then check up on the reasonableness of the number of horses sometimes represented in descriptions of this experiment. EDITOR.)

WORK ON A MOVING STAIRWAY

820. *Proposed by Dr. John C. Packard, Brookline High School, Brookline, Mass. (GQRA No. 1.)*

"Does it require more or less work on the part of the hoisting engine to carry a man up a moving stairway when he is walking up the stairs while the heads are moving than when he stands still?"

UNFINISHED BUSINESS

Answers are lacking to questions below:
Please have your pupils work on them and send in answers.
Contributors will be elected to the *GQRA* (Guild of Question Raisers & Answerers).

788. *Finding the Lusitania.* (SS&M, March, 1937.)
802. *The Hindenburg Disaster.* (June, 1937.)
804. *Anhydrous Ammonia as a Motor Fuel.* (June, 1937.)
806. *Waves & Vibrations.* (October, 1937.)
807. *For the Flyers.* (October, 1937.)

EXCHANGE OF BIOLOGICAL KNOWLEDGE

821. *From Sister Mary Stanislaus Costello, Mercy High School, Milwaukee, Wis. (GQRA No. 152.)*

"The Mercy Bio-ite Club wishes to exchange biological knowledge with other Biology Clubs (or Classes) of our country."
(Dr. O. D. Frank, please note.)

COUNTERCLOCKWISE ROTATION

815. *Proposed by Vernon McNeilus (GQRA No. 196), Clarion, Iowa.*

"When water is poured down a drain, it naturally and invariably seems to rotate in a counterclockwise direction.
Is this controlled by some physical law?"

Answer by Helen Jo Betts (Elected to the GQRA No. 202), Winner, South Dakota.

"In the northern hemisphere when water is poured down a drain, it rotates in a counterclockwise direction; in the southern hemisphere it will rotate in a clockwise direction. The explanation for this lies in the fact that the earth rotates from west to east and in so doing pulls the water in the direction of its rotation."

PHYSICAL SCIENCES

Submitted by N. D. McLaughlin (Elected to the GQRA No. 203), Science Master, University School, South Euclid, Ohio.

Please send in answers to questions numbered as follows: **822**-4a, **823**-6, **824**-10a, **825**-10b, **826**-12c.

PHYSICAL SCIENCES*—TWO YEARS—JUNE

Answer ten questions as indicated below.
Number and letter your answers ot correspond with the questions selected.

* *Copyright, 1937, by the College Entrance Examination Board.*

Atomic weights: H = 1; N = 14; O = 16; S = 32; Cu = 63; Ag108.
Gram-molecular volume = 22.4 liters.

Group I—**Answer four questions from this group.**

1. Define briefly: (*a*) molecule, (*b*) ion, (*c*) hydrolysis, (*d*) endothermic reaction, (*e*) isotope, (*f*) electron, (*g*) heat of vaporization, (*h*) potential energy, (*i*) wave-length, (*j*) principal focus.

2. *a*) Define energy and name three energy units.
   b) State the law of conservation of energy.
   c) Give an example for each of the following changes:
   (1) kinetic to potential energy;
   (2) electrical energy to heat energy;
   (3) mechanical energy to heat energy;
   (4) electrical energy to produce chemical change.

3. *a*) Show by means of a large sketch the approximate amount of bending of the rays of different colors when white light goes through a glass prism.
   b) What kind of light source will give
   (1) a continuous spectrum;
   (2) a bright line spectrum?
   c) A yellow flame is obtained if a platinum wire, dipped into a sodium chloride solution, is held in a Bunsen flame. Explain why this flame can be used as a test for the element sodium.
   d) What is the flame test for potassium? Why is this flame observed through blue glass?

4. *a*) **822.** The volume of a given amount of air at standard temperature and pressure is 1,000 cc. What will be the Centigrade temperature when both the volume and pressure are doubled?
   b) Discuss the physical principles involved in the liquefaction of air.
   c) How are the two main constituents of liquid air separated? Give a use for each.

5. *a*) Describe how an electric current flows in a wire.
   b) Describe how an electric current flows in a solution of an electrolyte.
   c) The same current is passed through solutions of
   (1) dilute sulphuric acid with platinum electrodes;
   (2) dilute silver nitrate solution with silver electrodes;
   (3) dilute copper sulphate solution with copper electrodes.
   What weights of silver and of copper will have been deposited when 1 gram of hydrogen has been collected?
   d) Describe and sketch a simple voltaic cell.

Group II—**Answer three questions.**

6. **823.** 189 grams of copper are treated with an excess of dilute nitric acid to give nitric oxide according to the equation

$$3Cu+8HNO_3 \rightarrow 3Cu(NO_3)_2+4H_2O+2NO.$$

   a) What volume of nitric oxide is collected at standard temperature and pressure?
   b) The remaining solution is evaporated to dryness. What is the weight of the residue?
   c) The residue is now decomposed by strong heat. What volume of mixed gases is collected at standard temperature and pressure?

7. *a*) Oxygen is collected by heating a mixture of potassium chlorate and manganese dioxide. The outlet tube is, by mistake, left under water after the gas jars have been removed and the heating discontinued. What do you predict will happen and why?
   b) Define catalyst. State a common reaction (other than that described in Part *a* of this question) in which oxygen is produced catalytically.
   c) How would you prove experimentally that manganese dioxide in Part *a* of this question is a catalyst?
   d) Describe a common reaction in which manganese dioxide is employed non-catalytically.

8. *a*) $2SO_2+O_2 \rightleftarrows 2SO_3+45{,}000$ calories.
   What does this statement mean?
   b) Describe the reaction in the Contact Chamber for preparing sulphuric acid and show that the information given in the reaction written in Part *a* of this question is usefully employed.
   c) In the Contact Process there are three stages:
   (1) sulphur→sulphur dioxide;
   (2) sulphur dioxide→sulphur trioxide;
   (3) sulphur trioxide→sulphuric acid.
   Indicate, by atomic diagrams, the states of the sulphur atom in these four substances. (The atomic number of sulphur is 16.)

9. *a*) Name five products made from crude oil.
   b) If C_8H_{18} represents the approximate composition of gasoline, write an equation for its complete combustion.
   c) If the combustion is incomplete, what two undesirable products are formed? Discuss briefly the harmful effects of these.

Group III—**Answer three questions.**

10. *a*) **824.** A weight lf 12 pounds is suspended by a rope from a hook in a vertical wall. By means of a second rope attached to the first just above the weight, a man pulls horizontally so as to hold the weight out 10 feet from the wall. If the horizontal pull on the weight is 5 pounds, what must be the tension in the first rope and how long must it be?
    b) **825.** A flexible chain is hung from two nails in the same horizontal line with enough sag so that the direction of the chain at each nail makes an angle of 45 degrees with the horizontal. If the weight of the chain is 100 pounds, what is the force exerted by each nail?

11. *a*) What is meant by an "induced current"?
    b) State the law by which the direction of the induced current can be predicted.
    c) Upon what does the magnitude of the induced electromotive force depend?
    d) Mention three practical applications of induced currents.

12. *a*) You are supplied with a lens through which you can look but which you are not allowed to touch. Describe any tests you would apply to determine whether the lens is concave or convex.
    b) The moon is about 2,000 miles in diameter. Draw a sketch of conditions during a total solar eclipse, showing how it is that the width of the moon's shadow on the earth may be only about 100 miles.

826. In an automobile the rear-sight mirror is 2 feet from the driver's eyes. The rear window is 8 feet from the mirror and is 1 foot high and $2\frac{1}{2}$ feet wide. How large does the mirror need to be in order that the driver, using the mirror, may see out of all parts of the rear window without moving his head?

13. A piece of unmagnetized iron can be converted into a magnet by
(1) stroking it with a permanent magnet, *or*
(2) placing it in a coil carrying an electric current, *or*
(3) hammering it while in the earth's field.
Explain the three methods and discuss the principles involved.

GQRA CONTRIBUTORS

1933—October to December, Nos. 1 to 10;.
1934—January to December, Nos. 11 to 47;
1935—January to December, Nos. 48 to 113;
1936—January to December, Nos. 114 to 154;
1937—January to December, Nos. 155 to 201.

Yourself or your pupils are entitled to membership in the GQRA (Guild of Question Raisers & Answerers) when you send in an answer to a published question or submit a question that is published. Teachers! It is a great game to play with and for your classes.

Pupils! It is a lot of fun to play this game which is as old as history. (They still ask questions of the Sphinx and have done so for forty centuries.)

JOIN THE GQRA!

THE QUESTION WITH 100 ANSWERERS

Wanted

A new or old member of the GQRA to submit a question of such interest that 100 Answers will be sent in to the Editor.

Teachers get your classes to working on such a question. Thanks!

BOOKS AND PAMPHLETS RECEIVED

Sound Waves Their Shape and Speed, by Dayton Clarence Miller, Professor of Physics, Case School of Applied Science, Cleveland, Ohio. Cloth. Pages xi+164. 14×21.5 cm. 1937. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.75.

A Short History of Chemistry, by J. R. Partington, Professor of Chemistry in the University of London, Queen Mary College. Cloth. Pages xiii+386. 12.5×19.5 cm. 1937. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.50.

Discovering Our World, A Course in Science for the Middle Grades, by Wilbur L. Beauchamp, Mary Melrose, and Glenn O. Blough. Book One. Cloth. 288 pages. 13×19 cm. 1937. Scott, Foresman and Company, 623 South Wabash Avenue, Chicago, Ill. Price 88 cents.

Glossary of Physics, compiled and edited by Le Roy D. Weld, Professor of Physics in Coe College, Cedar Rapids, Iowa. Cloth. Pages x+255. 13.5×10.5 cm. 1937. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.50.

The Classroom Teacher's Estimation of Intelligence and Industry of High School Students, by Harry Eisner. Contribution to Education, No. 726. Cloth. 108 pages. 14.5×23 cm. 1937. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $1.60.

The Teaching of Physical Sciences in the Secondary Schools of the United States, France, and Soviet Russia, by Alexander Efron, Contribution to Education, No. 725. Cloth. Pages vii+296. 14.5×23 cm. 1937. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $2.35.

A Leaf Key to Florida Broad-Leaved Trees, Native and Exotic, Except Palms, by Mary Franklin Barrett, Formerly of the State Normal School and the State Teachers' College, Montclair, New Jersey. Paper. 79 pages. 15.5×23.5 cm. 1937. Mary Franklin Barrett, 57 Union Street, Montclair, New Jersey. Price $1.00.

Dark Field Optical Systems. Catalog D-122. Paper. 13 pages. 21.5×28 cm. Bausch and Lomb Optical Company, Rochester, New York.

Unemployment in 1937. Reprint from *Fortune*, October, 1937. 16 pages. 28.5×40 cm. Works Progress Administration, Walker-Johnson Building, 1734 New York Avenue, N.W., Washington, D. C.

Erratum

In the Book Reviews for November the price of Schlauch's *General Mathematics for Students of Business* was given as $1.75. This should have read $3.75.

BOOK REVIEWS

Elements of Foods and Nutrition, by Mary T. Dowd, Formerly Teacher of Household Science, Washington Irving High School, New York City, and Alberta Dent, Associate Professor of Home Economics, New Jersey College for Women. Cloth. Pages xiii+279. 13×19.5 cm. 1937. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $1.75.

The diet of modern man is receiving more and more attention from scientists with the passing years. The long list of important discoveries made during the last third of a century showing the essential role of numerous vitamins and minerals in the normal development and health of man is constantly growing. And although the last word on many points cannot be said as yet, the time has come that a wide dissemination of established knowledge is greatly to be desired. The book here reviewed seems well fitted for such a task. Designed primarily for the high school student, it is nevertheless the "hope of the authors that it may serve also as a means of self-education in the principles of food selection for the adult and housewife whose school training did not include work in home economics." Students in college classes in biology and hygiene will also find it interesting collateral reading.

The book is a simple, clear, and accurate presentation of the basic principles of food selection for health. On the side of food preparation it emphasizes the underlying principles rather than techniques. The chapter headings are as follows: I Food and Health; II Cooking of Food; III Digestion, Absorption, and Metabolism of Food; IV Principles of Nutrition. 1. Adequate Energy; V Energy Foods. Carbohydrates. 1. Sugars; VI Energy Foods. Carbohydrates. 2. Starch. Cereals; VII Energy Foods. Carbohydrates. 3. Flour Mixtures; VIII Energy Foods. Fats and Oils; IX Principles of Nutrition. 2. Adequate Protein; X Protein Foods. 1. Dairy Products. Milk. Cheese. Eggs; XI Protein Foods. 2. Meat. Poultry.

Fish; XII Principles of Nutrition. 3. Adequate Minerals; XIII Principles of Nutrition. 4. Adequate Vitamins; XIV Vegetables; XV Fruits; XVI Principles of Nutrition. 5. Adequate Water and Fiber; XVII Beverages and Condiments; XVIII Food Combinations in Meals; XIX The Preservation of Foods; XX Fallacies Regarding Food and Food Habits.

Exercises and questions and a short list of reference books are included at the end of each chapter. There are numerous instructive diagrams and tables throughout the book. Half-tone pictures of foods add interest. Not the least of the valuable features is an appendix consisting of an unusually comprehensive table, covering nine double pages, showing the nutritive value of average servings of common foods, with key letters telling the source of the data. Numerical proportions of the following are tabulated: Proteins, Fats, Carbohydrates, Calories, Calcium, Phosphorus, Iron, Excess acid, Excess base, Fiber, and Water. Vitamin content of the foods is indicated by the usual method of plus signs. There is an adequate index.

EDWARD C. COLIN

A Hundred Years of Chemistry, by Alexander Findlay, Professor of Chemistry in the University of Aberdeen. First Edition. Pages 352. 15×22× 3.2 cm. 11 figures. Cloth. 1937. $4.25 New York; The Macmillan Co. Great Britain; Kemp Hall Press, Ltd. Oxford.

This excellent work is, in part, a history of chemical progress during the past one hundred years, and also in part a condensed synopsis of much of the chemistry, physical, organic and industrial that has been discovered during that time. There is also much of the biographical background presented, and, in an appendix of twenty pages, the author gives us brief biographical notes on most of the great men whose work is reviewed.

A sampling of many of the pages suggests that the review of progress in physical chemistry is rather more adequately and completely handled than is the case with, say, industrial chemistry. It is only fair to say that but one short chapter is devoted to the latter field whereas there are three longer chapters on physical chemistry. A quite complete discussion of advances in organic chemistry is given.

This work is a most suitable one for the teacher of chemistry who wishes to review any of the several fields treated in the book, whether it be the historical, the biographical or the factual side that is of interest. The treatment is too concise to be useful to the untrained student who has not already studied the subject matter itself, for the achievements of one hundred years in chemistry constitute a rather large order for a beginner to absorb in so compact a form.

There is to be noted throughout the book a most judicial attitude toward the matter of credit for and priority in discovery of the new facts, and laws of chemistry and there is evidence of much painstaking work in searching (and referring to) the original sources.

FRANK B. WADE

Experimental Radio, by R. R. Ramsey, Professor of Physics, Indiana University, Fellow American Physical Society, and Member Institute of Radio Engineers. Fourth Edition. Cloth. Pages xiv+196. 15×22.5 cm. 1937 Ramsey Publishing Company, Bloomington, Indiana. Price $2.75.

Experimental Radio has grown from a very modest pamphlet in 1923 to a comprehensive manual of radio experiments covering all phases of

the subject from those involving the simplest circuits to the latest developments in theory and practice. It is not a mere compilation of experiments from other books and journals, although the author has drawn extensively from such sources where good experiments were available for his purpose, but many of the experiments are of his own design. In the main these may be performed with very simple apparatus. With many of these exercises directions are given for constructing the apparatus. While the book is highly practical and a minimum of theory is included, it is not at all of the cookbook type. Some simple theory is included and references are numerous to the author's *Fundamentals of Radio* and to other texts and journals. The text is at the college undergraduate level and contains an abundance of material for a course requiring several months. The experiments in this edition have been adapted for use of rectified alternating current. Experiments on television, photoelectric cells, cathode ray oscillographs, and the study of attenuators and characteristic impedance are some of the new features. The book contains 132 experiments, a short section on laboratory apparatus, and a list of important reference books and periodicals. As a practical manual for college classes this book is now without a peer.

G. W. W.

Foundations of College Physics, by Samuel Robinson Williams, Professor of Physics, Amherst College. Cloth. Pages x+630. 15×23 cm. 1937. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $4.00.

This is one of the excellent new textbooks in college physics that will no doubt be given a hearty reception. Its author is well known as a teacher, author, and investigator. His teaching ability is indicated by the first chapter, which catches the interest and gives valuable hints on study. The fundamental ideas of measurement are presented in an interesting and effective manner. This first chapter is a good illustration of the method of presentation used throughout. The author has not attempted to cover in detail all the topics frequently included in general physics texts. Instead he has treated the more fundamental topics in a thorough manner, thus providing a basic course, but leaving it to the instructor to supply the trimmings by lectures or directed reading. This text is reliable and up-to-date, makes use of the discoveries in electronics and other relatively new fields where they provide explanations that can be mastered by the beginner, but it holds close to the classical development. The approach is experimental rather than analytical. It is well supplied with exercises and review outlines. Valuable reference material and tables are included in the Appendix.

G. W. W.

ANOTHER ICE AGE

Lower the average temperature by forty degrees and another Ice Age would chill and whiten the earth; lower it forty more and life would be impossible. Cut off solar heat for a year, and the atmosphere would pour down in torrents of liquid air.—H. D. Grant, British naval meteorologist, in *Thought*.